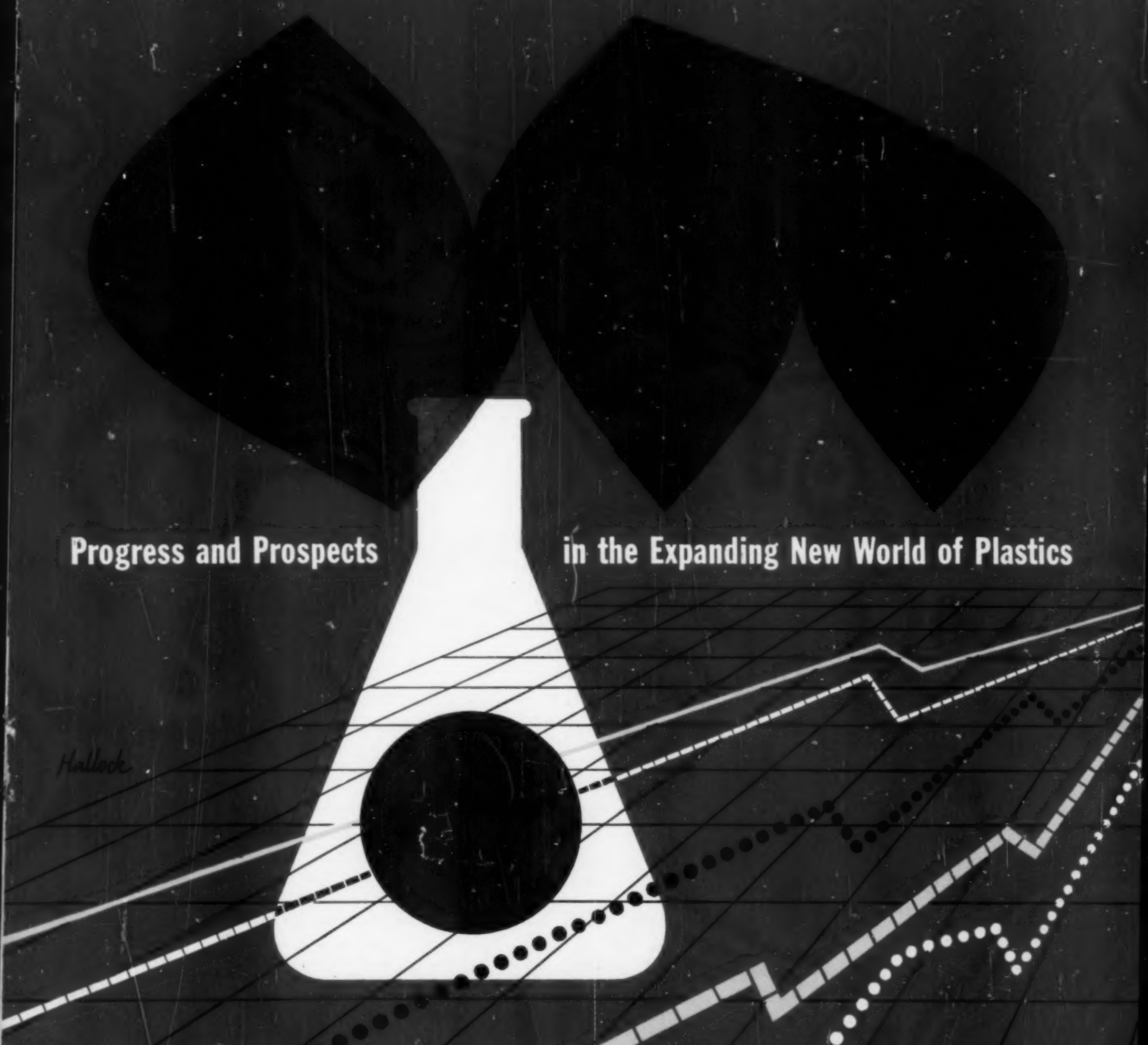
MODERN PLASTICS

JANUARY 1958

1957 Review • Outlook 1958



MODERN PLASTICS*

Editorial

The Plastiscope

General Section

Plastics Engineering

Technical Section

Departments

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Editorial

Watch these trends in 1958

Last year was a year of entrenchment and refinement in plastics applications and processing methods.

This is to be a year of broadening bases—of opening up vast new markets for plastics—of battles between new resins, processes, and machinery and old ones—of increased (and much needed) attention to distribution.

In the lines and between the lines of this issue of MODERN PLASTICS certain clear trends appear. We suggest that readers consider the following ten trends and use them to advantage:

1) More use of plastics to ease the cost-profit squeeze on end-user industries.

2) Much more use of plastics in building construction through composite sandwich structures, foams produced in place, honeycombs, reinforced plastics, vinyl-metal and thermoset-metal laminates, and coatings.

3) More alloys and copolymers in all polymer groups to achieve superior properties.

4) Full automation in molding, extruding, and forming, particularly in captive plants. More single-purpose machines, built around molds.

5) More thermoset reinforced premixes and reinforced thermoplastics for automatic molding. Machines may be fed from rods or from spools of loaded rope.

6) Greater use of extruders, even in molding processes. Bigger extruders with much more complicated dies for big production are on the boards.

7) Bigger thermoforming machines and bigger thermoplastics sheets. Three-dimensional billboards on the way with huge weather-resistant sheets.

8) More use of the slush and rotational molding processes with both soft and rigid plastisols and the new polyolefins.

9) More disposable items of all kinds in plastics.

10) Companies now in the distribution of sheets, film and structural materials due to expand. New ones will be established.

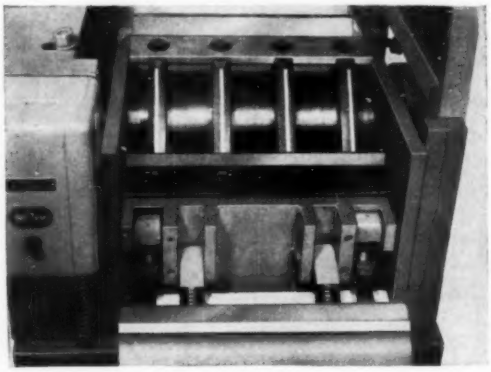
• • •

These ten are but a small part of the whole trend picture in plastics. 1958 will be a year for thorough reading of MODERN PLASTICS.

TWO NEW Cumberland

Beside The Press

GRANULATING MACHINES



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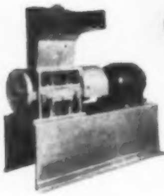
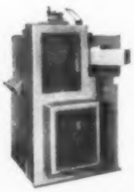


CENTRAL GRANULATING MACHINES

The Cumberland Model 20 shown left is one of a series of rugged, high quality central granulators offering a choice of throat openings and power.



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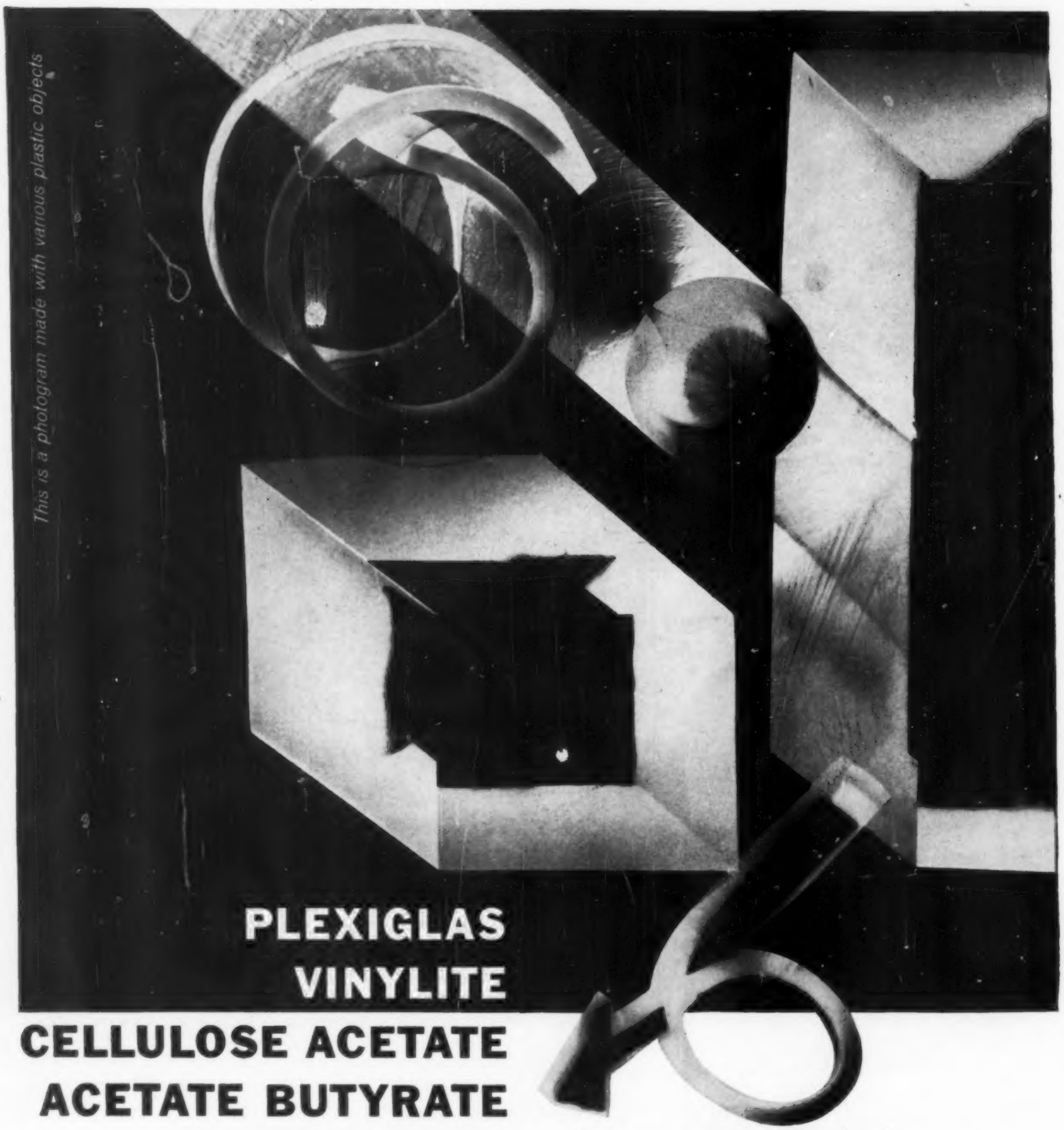
This is a photogram made with various plastic objects

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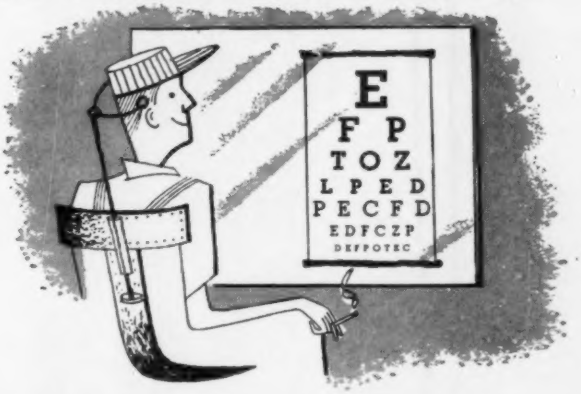

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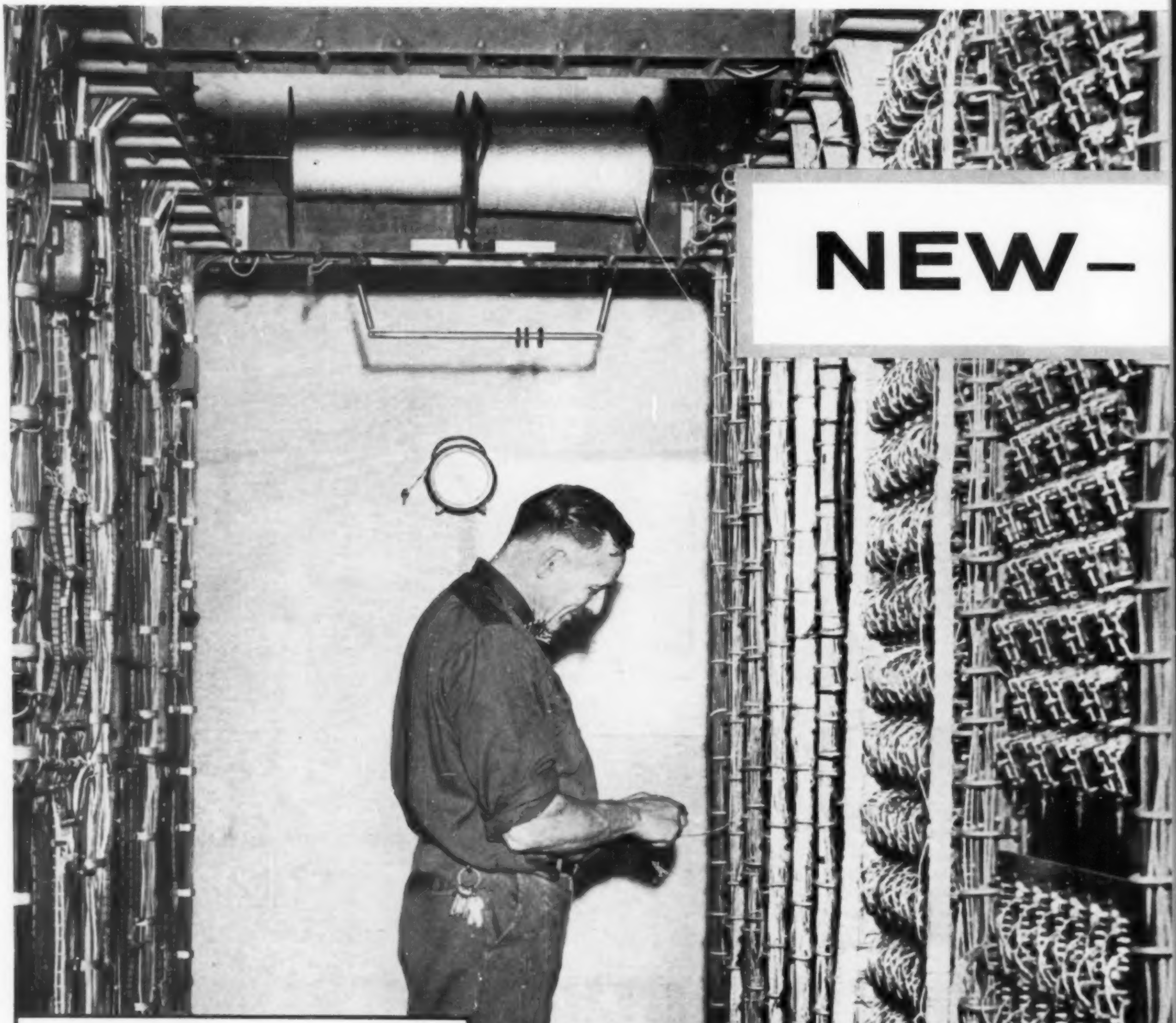

Typical Properties of a Plastisol Based on PLIOVIC VO

Viscosity, Brookfield @ 2 rpm	13,000 @ 1 hour 12,600 @ 1 week 9,000 @ 1 month
Tensile strength, psi	2430
Elongation, %	403
100% Modulus, psi	1050
Hardness, Shore "A"	80
Crescent Tear, lbs./in.	287
Volume Resistivity, ohm-cms.	1.09×10^{13}

Note: All test samples contained 100 parts resin, 60 parts DOP and 1 part RS-20 except the electrical sample which contained 100 parts resin, 50 parts DIOP and 10 parts Oil Tribase E.

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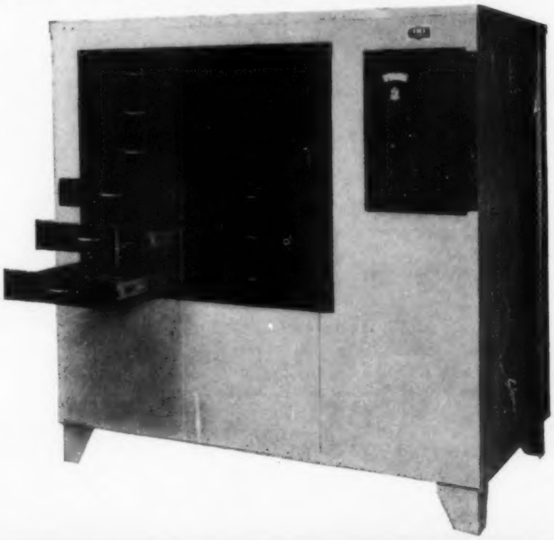

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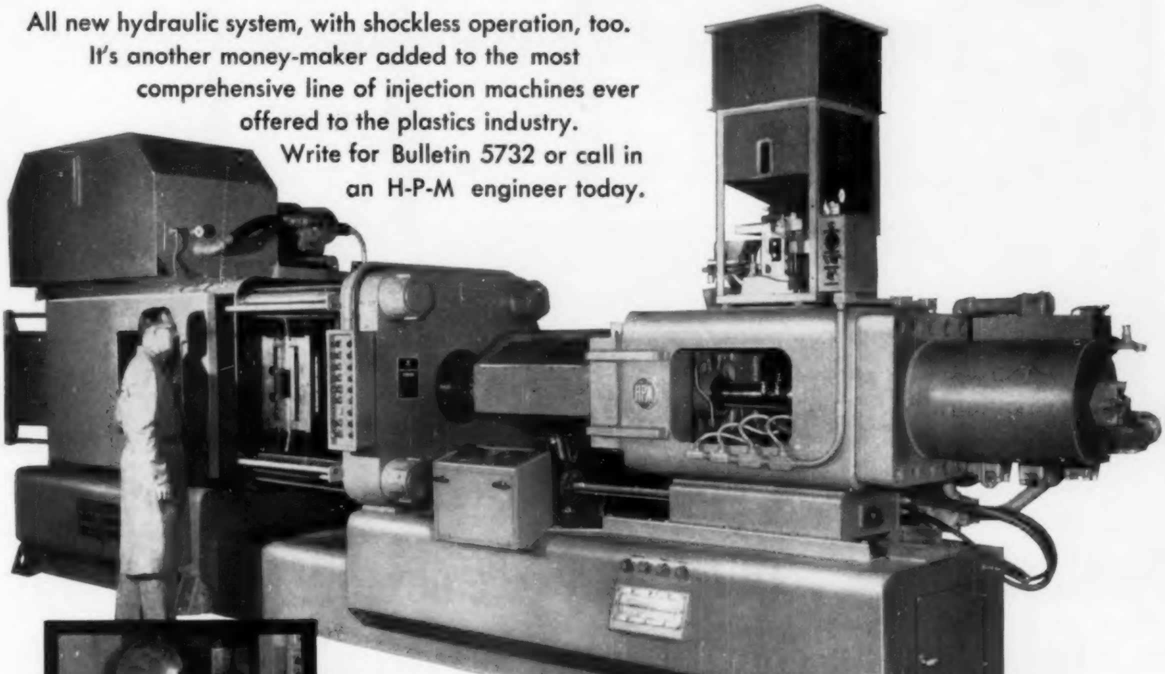
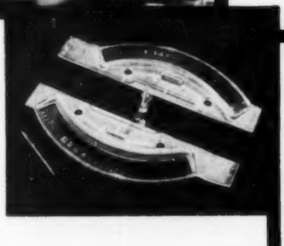


And here it is at ERIE RESISTOR CORPORATION, Andover Industries Division, Andover, Ohio, molding Plexiglas instrument clusters for a 1958 automobile—in a two cavity mold.



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Clamp Tonnage	650
Platen Size	48"x48"
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Daylight (Without Ejector Box)	58"
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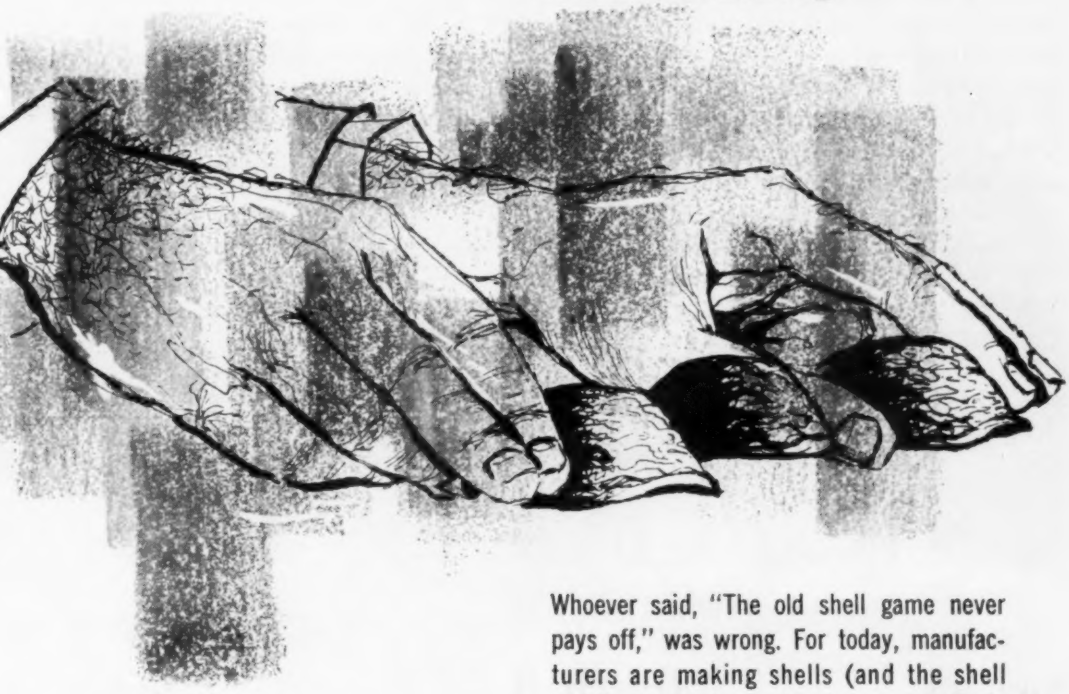
PLENCO SHELL MOLDING RESINS

Careful consideration of the shell can be most rewarding



Whoever said, "The old shell game never pays off," was wrong. For today, manufacturers are making shells (and the shell molding method) pay handsome rewards in the production of molded parts. We refer, especially, to those companies who rely on Plenco phenolic molding resins.

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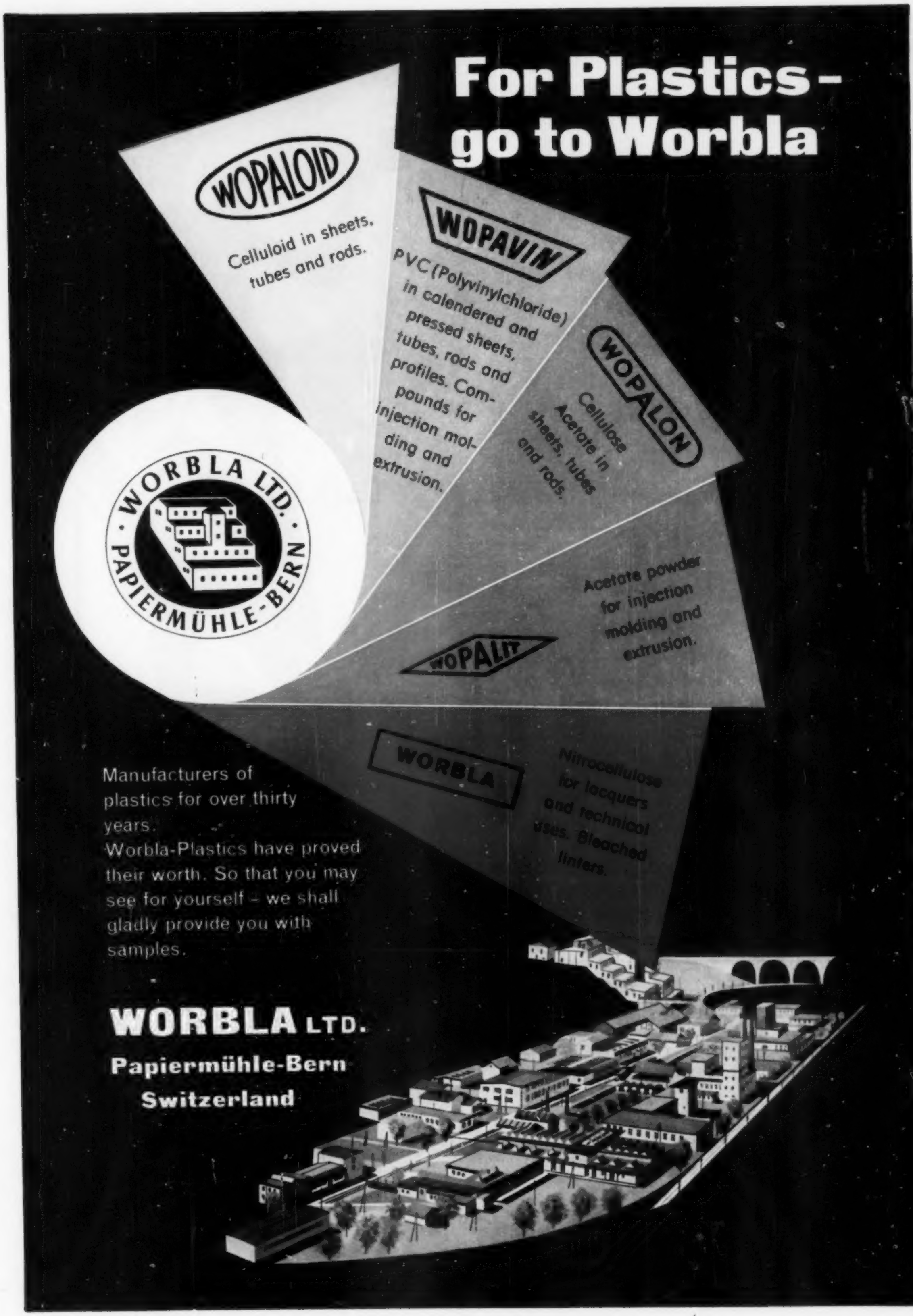
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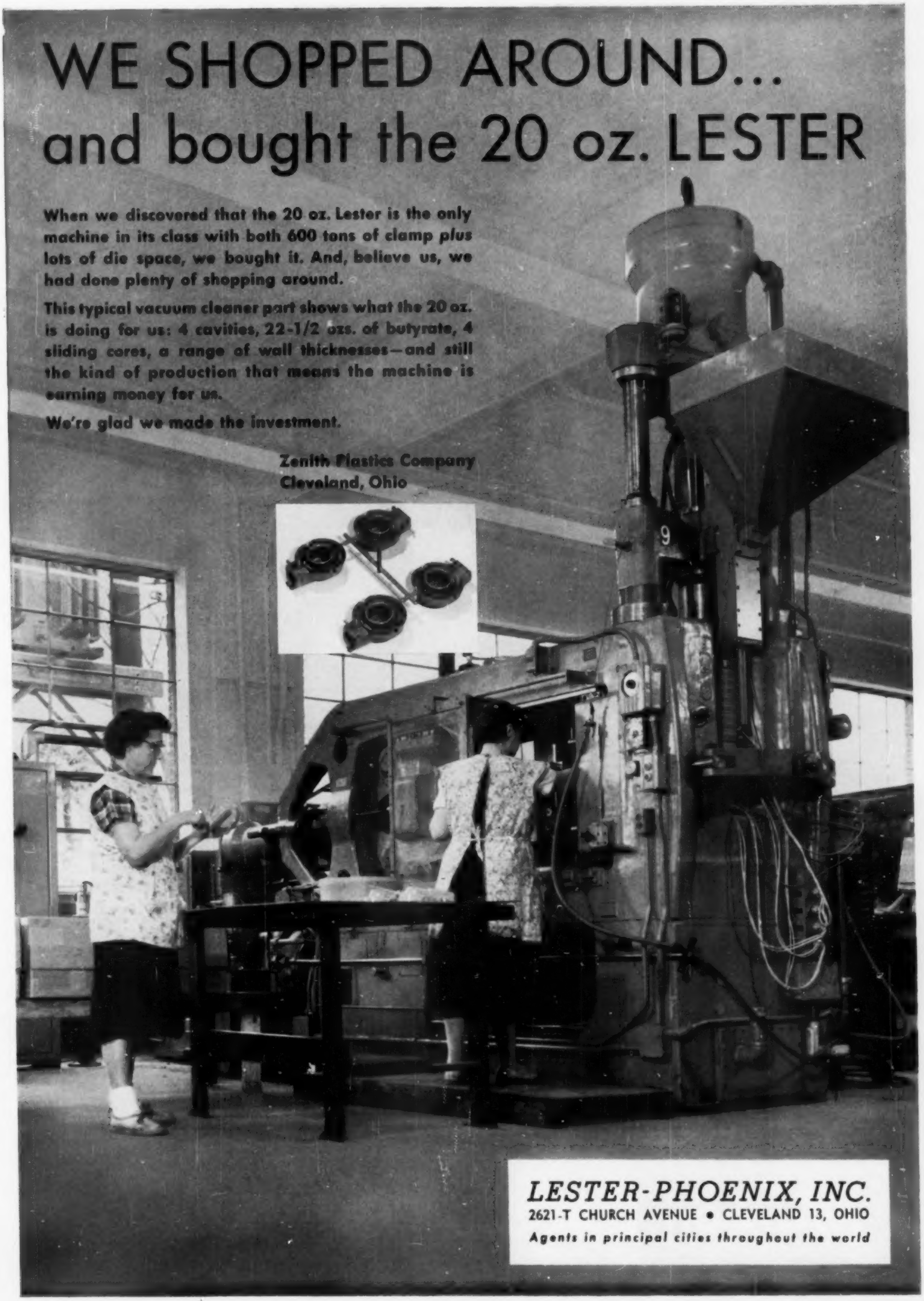
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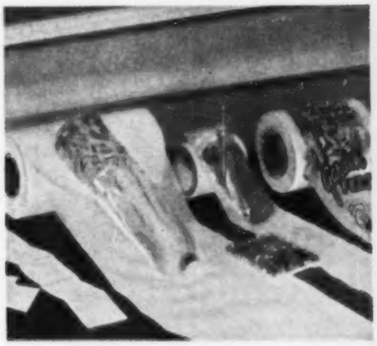

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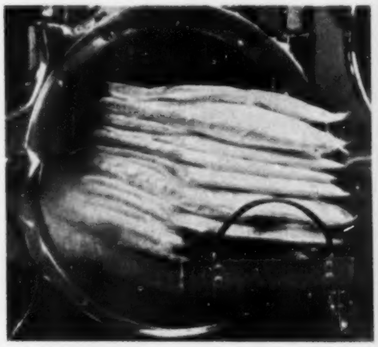

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*MARLEX is a trademark for Phillips family of olefin polymers.

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The Plastiscope* January 1958

News and interpretations of the news

By R. L. Van Boskirk

Section 1

Polypropylene plant on stream. As predicted in this magazine several times, an American company has started commercial production of polypropylene. That firm, Hercules Powder Co., came on stream December 1 with an announced capacity of 20 million lb. a year. The new plastic, which will be known as Pro-fax, will be produced in new facilities that have been added to the company's low-pressure-process polyethylene plant at Parlin, N. J.

Successful production of polypropylene in the United States means far more to plastics than the introduction of one new and significant plastic. It is the beginning, or at least a long step forward, in the production of plastics by a stereospecific system or method which polymer chemists and research directors at the Notre Dame polymer conference declared was the most important development in plastics since the discovery of phenolic resin.

"Stereospecific plastics" is a branch of "stereochemistry," which the dictionary defines as that department of chemistry which relates to the relative position of atoms in a molecule. A rough definition of stereospecific plastics for the layman might be "that group of polymers in which the molecules are constructed according to a predetermined geometric pattern, which in turn determines the properties of the polymer." Hercules describes its propylene as an "ordered crystalline polymer."

Thus, stereospecific plastics at their maturity (they're only new-born babes at present) will result in plastics especially built for a specific purpose. There are so-called tailor-made plastics today, but the tailor-making of the future will be as different as that between tailor-made overalls and a tailor-made tuxedo. (See section on polyethylene, page 101 of this issue, for further discussion of polypropylene and prospective producers.)

Hercules' three-year triumph. The amazing part of the Hercules performance is that its polypropylene was developed from laboratory to plant in three years' time, compared with the usual five to seven years expected in plastics development. This accomplishment was aided by experience in development of low-pressure-processed polyethylene and consequent use of Ziegler catalysts which, it is assumed, have been an important element in the development of the process of manufacturing polypropylene.

Samples of finished Pro-fax polypropylene currently being shown by Hercules indicate its usefulness in molding, extrusion, film, and fiber. It is the lightest of all plastics with a specific gravity of 0.910; conventional polyethylene has a specific gravity that starts at about 0.918 for general-purpose material. Pro-fax will reportedly withstand more heat than low-pressure polyethylene and is said to give satisfactory results in molds now used for other plastics. It is

*Reg. U.S. Pat. Off.

The Plastiscope

(*Continued from page* 37)

said to have higher tensile strength, hardness, temperature resistance, stiffness, resilience, and clarity than other polyolefins, together with the inertness and water resistance characteristics of a hydrocarbon polymer.

Hercules claims that the problems of oxidation and creep generally associated with polypropylene have been overcome. But it is generally agreed that its flexibility at extremely low temperature is not as good as polyethylene.

Applications for polypropylene. Molded hospitalware items are already in production. Home appliance housings; valves; bottles; automotive parts, such as steering wheels; toilet seats; pipe, including hot water pipe; film; sheet; and fibers are all possible applications.

The introductory price of the Hercules resin is 65¢/lb., but it will compete in properties with even higher-priced resins and may be used in thinner sections than some of the other thermoplastics. It is also expected that large-scale operating economies will result in lower prices to make it fully competitive with lower-priced thermoplastics.

Montecatini enters American market with polypropylene. December might be described as propylene month in American plastics history since Montecatini, too, chose that time to announce availability of its propylene, called Moplen, from its Ferrara plant in Italy. The announcement was not unexpected since its plans to produce the material were announced at the time of the New York plastics exposition two years ago.

Moplen will be available in the United States through Montecatini's representative in this country, Chemore Corp., 21 West St., New York 6, N. Y. Price in the United States has not been announced, but Moplen is being marketed in Italy at around 60¢ a pound. When tariff duties and freight are added, cost in the United States would be much higher. Montecatini has made no statement as to whether or not the company will license producers in this country or build a plant of its own.

Montecatini is a pioneer in the development of stereospecific catalysts and asserts that its Professor Giulio Natta is the discoverer of catalytic agents which will act on olefins to produce regularity of structure and permit control of crystallinity. When a high degree of crystallinity can be controlled, such properties as high heat resistance, resistance to solvents, and unusual electrical performance can be built in. Professor Natta named this polymer structure "isotactic," which is derived from the Greek "isos" meaning "the same" and "tato" meaning "regular order." (See MODERN PLASTICS, *34*, 300, Oct. 1956.)

A technical information leaflet describing Moplen's properties can be obtained from Chemore Corp. Among these properties are a heat resistance, when not subject to strain, that may go to 302° F.; specific gravity of 0.90-0.91; melt index varying from 20-6; brittleness temperature of 14° F.; and softening point of (Vicat) 284° F.

The two types now in production are M1 with a melt index of about 20, suitable for film and blow molding, and M2 with a melt index of about 6, suitable for injection molding and extrusion of shapes. Many other types will be offered in the future. (*To page* 41)

The Plastiscope

(*Continued from page* 39)

Propylene monomer production. Sinclair Chemicals, Inc., a subsidiary of Sinclair Oil Corp., is now constructing the first high-purity propylene plant in North America. The new plant is at Marcus Hook, Pa., near Philadelphia, and will provide monomer for the Hercules plant (see p. 37) at Parlin, N. J. Propylene monomer can be shipped under pressure just like LPG (liquid petroleum gas such as propane and butane) that is used for heating purposes. Ethylene, on the other hand, is generally moved only under pressure in pipe lines. For that reason a polyethylene plant must be built near a monomer plant.

Propylene is contained in refinery gas streams and used for manufacture of gasoline components or burned as a waste product. In order to make it useful for plastics, a high state of purity must be obtained and an expensive plant built for the purpose. For this reason it is doubtful that propylene will ever be less costly than ethylene.

Escambia Pearls. What is asserted to be a unique series of PVC homopolymer resins produced by what is called a new concept in PVC polymerization, has been announced by Escambia Chemical Corp. The Escambia "Pearls" are characterized by an extremely large, uniform particle size. Since "fines" are absent, the resins are dust-free in factory operations. A spokesman for Escambia says that these PVC "Pearls" will absorb up to twice as much plasticizer as any competitive resin. This property makes possible the use of a larger percentage of low-temperature plasticizers and thus helps to make a PVC product less stiff in a cold atmosphere, or it may help to make a "softer" resin that flows more freely in processing operations.

The new "Pearls" are particularly useful for dry blends because they produce a compound that is uniform and free flowing even at abnormally high plasticizer levels. Extrusion and calendering resins made from "Pearls" show unusually fast fusion times and very low gel counts. Crystal clear and gel-free extrusions have been made, using FDA approved plasticizers and without metallic stabilizers.

New PVC resin source. Great American Plastics Co., Fitchburg, Mass., is celebrating its 35th Anniversary by placing on the market polyvinyl chloride resins through its Irvinil Division. The company expects to develop custom-tailored resins and will test all resins in the company's own manufacturing program before they are offered for sale. Herbert J. Cronin, Jr. has been appointed sales manager of the Irvinil Division.

Initially, two types of PVC resin are available—610, a general-purpose, high-molecular-weight polymer with excellent electrical properties especially suitable for extrusion, and 620, a medium-molecular-weight polymer recommended for calendering, injection molding, and extrusion.

Acrylic resin for low-pressure laminating. As had been forecast in this column in the past, Du Pont has now officially announced the first all-acrylic general-purpose, laminating resin under the term "acrylic sirup" and the Lucite trademark. The new resin makes the beauty and weatherability of pure acrylic

Garan® Roving helps Amercoat* meet Rigid Specifications for Glass-Plastic Railing

Garan Roving-reinforced plastic railing at Del Mar Turf Club (California) withstands routine "bumping" from tractors—or horses—without buckling or damage.

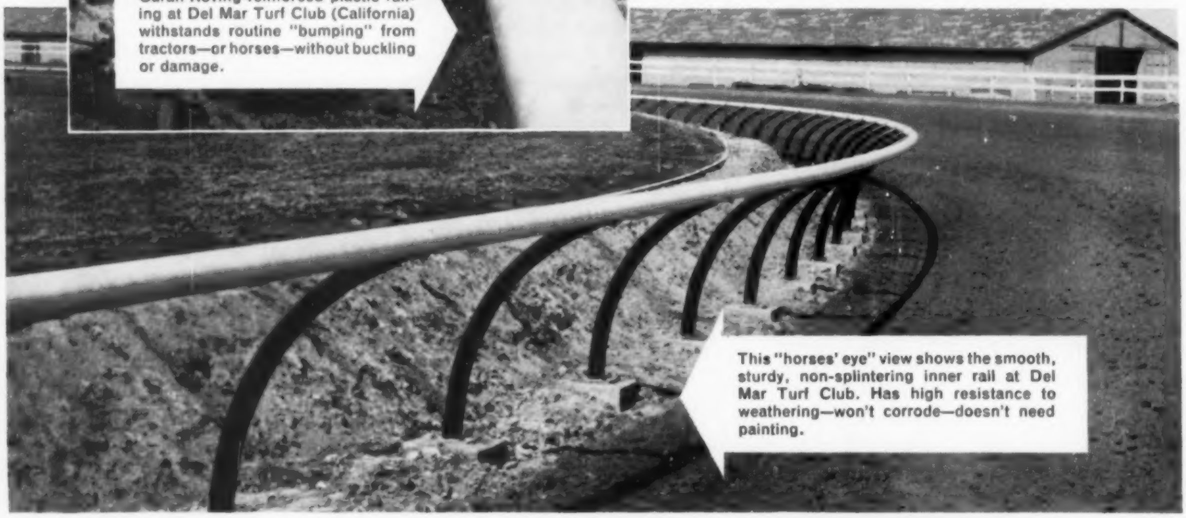
Improved weathering characteristics and higher physical properties make this glass-reinforced plastic tubing ideal for many architectural uses—both exterior and interior.

**Amercoat Corporation, South Gate, California* found that Garan Roving met their exacting requirements in making tubing in diameters from 2" to 12"; with more strength than steel on a weight basis; unusually high flexural strength; lighter than aluminum; better weatherability.

Here's why Garan Roving did the job:

1. Faster resin wet-out... better bond... speeds production.
2. Improves flexural, compressive and tensile strengths.
3. High wet strength retention... adds durability.
4. Packaged for rapid, trouble-free pull out... cuts fabrication time.

Garan Roving, made by L·O·F Glass Fibers Company, is the quality reinforcement for preforming, corrugated sheet, rod stock, and woven roving applications.



This "horses' eye" view shows the smooth, sturdy, non-splintering inner rail at Del Mar Turf Club. Has high resistance to weathering—won't corrode—doesn't need painting.

For technical information about Garan Roving and how it can improve your product, call our nearest sales office, or write: *L·O·F Glass Fibers Company, Dept. 15-18, 1810 Madison Avenue, Toledo 1, Ohio*

LOF GLASS FIBERS

L·O·F GLASS FIBERS COMPANY TOLEDO 1, OHIO

The Plastiscope

(*Continued from page* 41)

available for low-pressure laminates in applications requiring increased strength, rigidity, and toughness. Because of its well-known properties of clarity and weatherability, this acrylic sirup gives laminates an initial water-whiteness and freedom from color changes after prolonged periods of outdoor exposure. In addition, tested laminates have shown unusually good retention of gloss and resistance to surface erosion. Resistance to damage by impact and abrasion has also been outstanding. The unusual properties of Lucite sirup result largely from the absence of aromatic components normally present in other compositions.

Lucite sirup is tailored especially for impregnation of fibrous reinforcement and can be processed by methods now used in the reinforced plastics industry. Proposed applications include panels for patio roofs, truck trailer skylights, awnings, industrial glazing, billboard trim, and bodies for the transportation industries.

There has been no announcement concerning price, but since it is believed that the resin is a partially polymerized methacrylate monomer and since monomer sells at 29¢, the ultimate cost may be reasonably competitive with polyesters. Test marketing will begin early in 1958.

Grace polyethylene plant on stream. W. R. Grace & Co.'s Polymer Chemicals Div. has announced that its high-density polyethylene plant in Baton Rouge, La., is now on stream. Grace is a licensee of Phillips Petroleum Co.

The new plant for producing Grex polyethylene has an annual capacity of 50 million pounds. Investment in plant, research, and development facilities exceeds $18 million.

When the permanent commercial ethylene supply contracted for by Grace was delayed, the company moved in the required monomer for beginning operations by high-pressure gas truck trailers, a most unusual procedure in transporting ethylene, but necessary so that Grace could meet early commitments. Another division of Grace, Davison Chemical Co., was instrumental in developing the catalyst presently used and is now working on catalysts for other polyolefins.

A staff of 225, with an annual payroll of $1.5 million, will man the plant on a three-shift basis.

New plant to utilize linear polyethylene. A new million dollar housewares and tableware firm will be launched this month by Ideal Toy Corp. to produce housewares and tableware from Celanese' Fortiflex linear polyethylene. The new company will be called Idealware, Inc. and will be directed by Alfred C. Manovill, vice president in charge of sales.

Idealware will be the first company to offer a complete line of low-pressure-processed polyethylene housewares, special properties of which will be toughness, unbreakability, and ability to withstand sterilization. Commercial production is scheduled to start in February at Hollis, L. I. The tableware line is being created by Russel Wright.

For additional and more detailed news see Section 2, starting on p. 248.


These machines give
most economical production
The fully automatic operation, simple electro-mechanical design with an amazing record of quality maintained over long production runs at lowest initial and lowest operating costs are the outstanding characteristics of BATTENFELD INJECTION MOLDING MACHINES
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For in-plant coloring of polyethylene, S-T-R-E-T-C-H goes a long, long way and guarantees uniform color-dispersion to end-products every time! Formulated from virgin polyethylene and carefully selected, time-tested pigments, S-T-R-E-T-C-H comes in uniform size, dust-free pellets packed in 50 lb. bags. And it blends easily and quickly with natural polyethylene in only 5 minutes!

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for the new Gillette *Adjustable* RAZOR

by ERIE PLASTICS

The new luxury Gillette is a fine precision instrument with a micrometer collar permitting nine different settings of blade exposure for light, close or extra-close shaves.

The new razor demanded a revolutionary package to match it in quality appeal. It's a rich metallic blue polystyrene case, with nameplate and crest in gold relief. The razor and blade dispenser rest on a blue polystyrene platform finished with blue flocking. For traveling, the platform is removable, the vinyl wrappers are snapped around it, providing a compact, space-saving travel kit.

ERIE not only custom molds the case and platform, but also assembles the complete package with bengaline liners, puffs, and wrappers. Make *your* package help sell *your* product and get it all from one source . . . ERIE Plastics.

ERIE *Plastics Division*
ERIE RESISTOR CORPORATION
MAIN OFFICES: ERIE, PA. • U.S.A. FACTORIES: ERIE, PA. • HOLLY SPRINGS, MISS.

Uniformly molded gage cases are examined by Insulation Manufacturing officials. Left to right: Walter Dunham, Assistant Production Manager; G. W. Starke, Production Mgr.; R. W. Starke, Sales Manager.

Cuts preheating cycles with NEW 3RB at Insulation Manufacturing

Since 1943, Insulation Manufacturing Company, Brooklyn, N. Y., has installed 10 THERMEX* Plastic Preheaters. Two Model 3RB units have now joined the force and are giving these results, according to Walter Dunham, Assistant Production Manager:

"Preheating cycles have been cut considerably, especially on smaller loads, because the automatic load cycle control permits us to carry higher preform temperatures."

The THERMEX 3RB Preheater holds a uniform preform temperature, load after load, automatically compensating for changes in moisture content, preform density, room temperature. Cuts reject losses. Steps up production.

Write for Bulletin T95R4 on the 3RB or call the nearest sales office.

* THERMEX—Trade-Mark Reg. U. S. Pat. Off.

View in molding department showing latest Model 3RB Preheaters.

the GIRDLER Company

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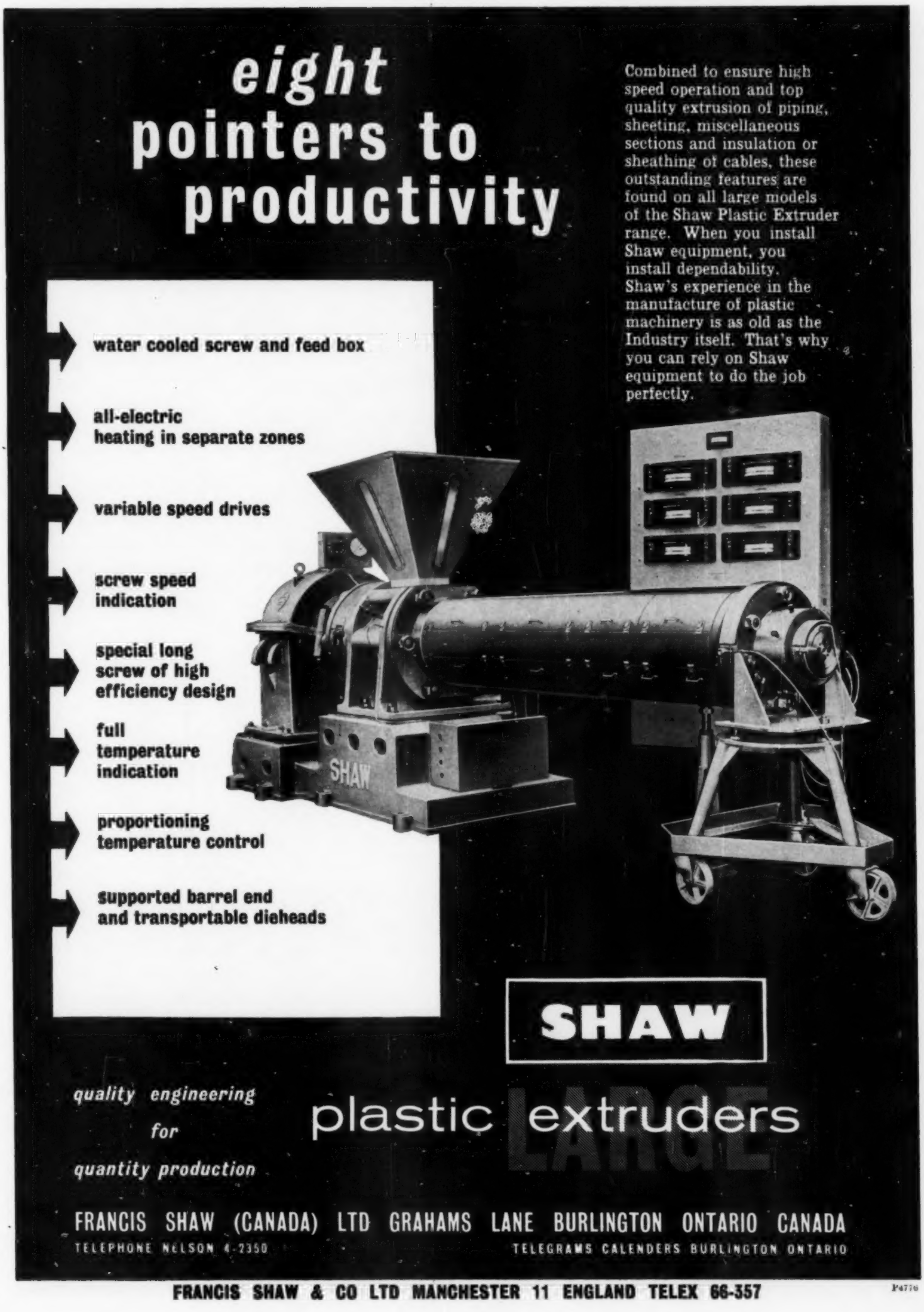
eight
pointers to
productivity
Combined to ensure high speed operation and top quality extrusion of piping, sheeting, miscellaneous sections and insulation or sheathing of cables, these outstanding features are found on all large models of the Shaw Plastic Extruder range. When you install Shaw equipment, you install dependability. Shaw's experience in the manufacture of plastic machinery is as old as the Industry itself. That's why you can rely on Shaw equipment to do the job perfectly.
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all-electric heating in separate zones
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NB/160 - NB/200
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Because of the progress and experience achieved through our constructive tecnique we can afford to give
A LONG LASTING GUARANTEE
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BUILT-IN ELECTRICALLY-CONTROLLED DIRECTIONAL VALVE

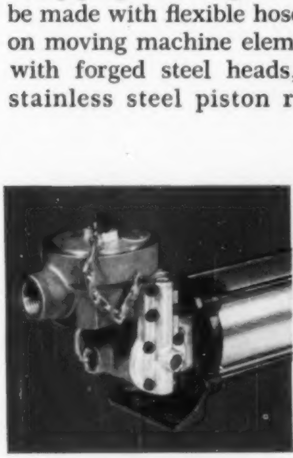
BUILT-IN DUAL SPEED CONTROLS

REQUIRES ONLY A SINGLE AIR CONNECTION

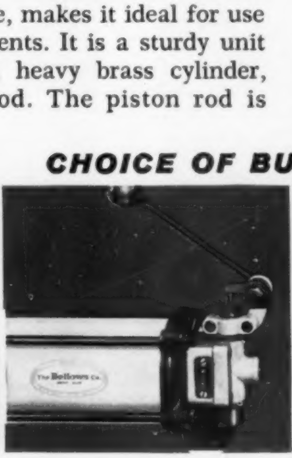
THE BELLOWS AIR MOTOR

The Bellows Air Motor is a complete air cylinder power unit, with directional valve and speed controls built-in. Takes less than half the space and costs less installed than a conventional air cylinder set-up of equal power with its separate valving and piping. The single air connection, which can be made with flexible hose, makes it ideal for use on moving machine elements. It is a sturdy unit with forged steel heads, heavy brass cylinder, stainless steel piston rod. The piston rod is threaded, equipped with a wrench flat and nut. Many Bellows Air Motors have been operating day in and day out for fifteen years with negligible maintenance. And if service needs do arise, there is a Bellows Field engineer as near as your phone. The Bellows Air Motor shown above is a 2½" bore unit equipped with the Bellows Low-Voltage (8-12V) Electroaire Valve. Other bores available are 1¼", 1¾", 3⅝" and 4½". Any stroke length. Optional choice of built-in valves as shown below.

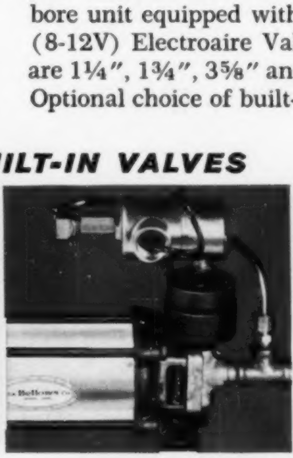
CHOICE OF BUILT-IN VALVES



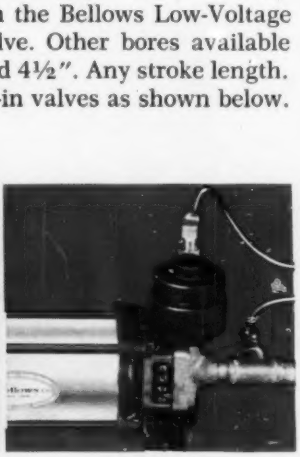
115 V. ELECTROAIRE VALVE
For J.I.C. applications where a 115 v. momentary contact is desirable.



MECHANICAL VALVE
For manual operation or for use with cams or direct linkage.



115 V. MAINTAINED CONTACT
Valve remains in shifted position during period current is applied.



AIR-OPERATED
For use in applications calling for full pneumatic control.

Write for these two booklets

Fifty pages of data to help you select the right Air Motor-Valve combination for your job. Address Dept. MP-158, The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd., Toronto 18. Ask for Bulletins BM-25 and SP-55.

The Bellows Co.
DIVISION INTERNATIONAL BASIC ECONOMY CORPORATION
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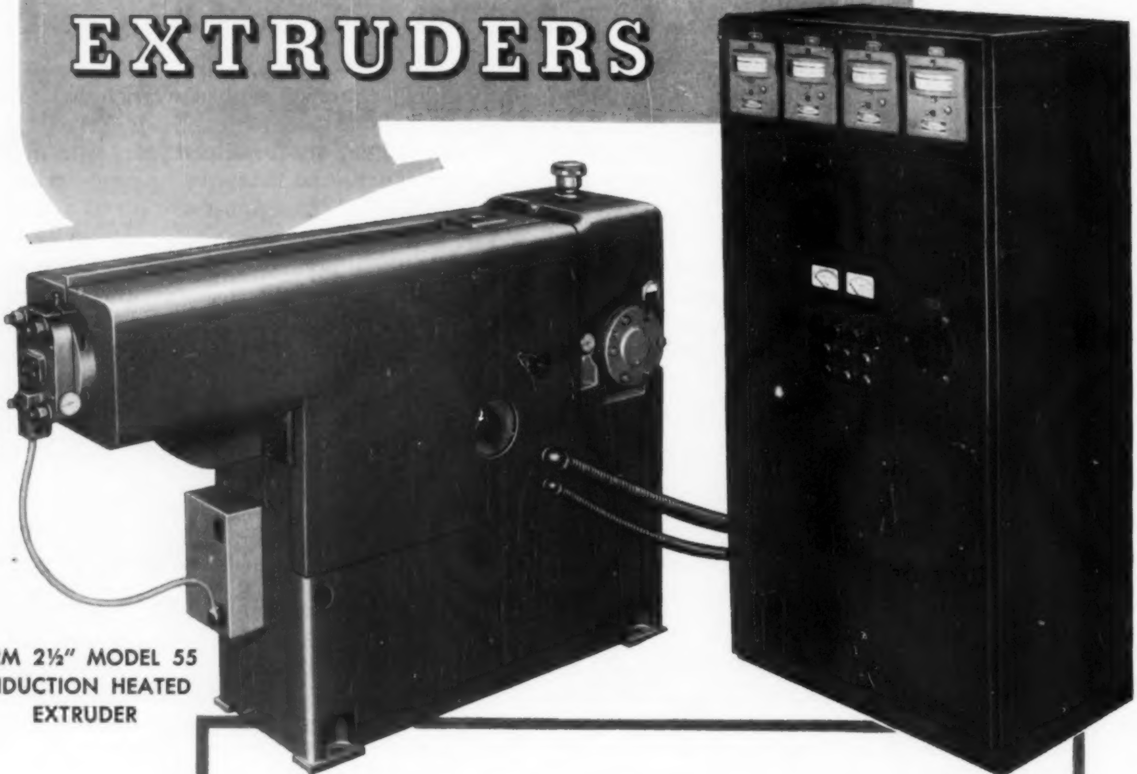
983-B

NEW for you in 1958...

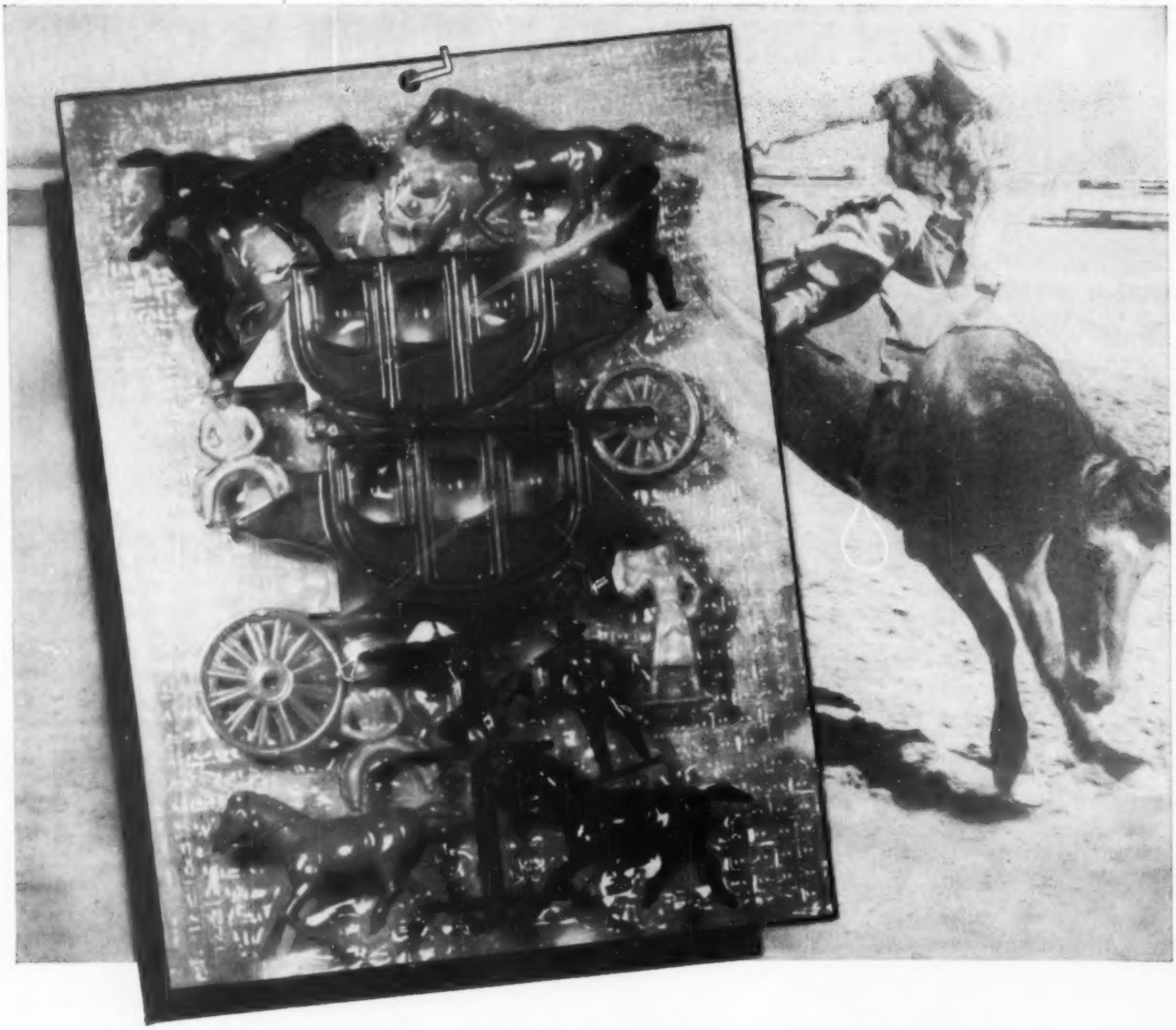
NRM *Induction Heated* THERMOPLASTICS EXTRUDERS



NRM 2½" MODEL 55
INDUCTION HEATED
EXTRUDER

NRM Extruders with patented "Balanced Heat Control"* were the *first* electrically heated machines to give the plastics industry the extruder temperature control required for production of high quality, close tolerance extrusions. "Balanced Heat Control" has *continued* to be the most economical and efficient system in use, due to engineering refinements made along through the years. Typical of such refinements was our application of "Cast-In" Heaters. But NRM's researches for a "still better" way to heat, and control the heat of extruders never ceased . . . Today, the fruit of intensive developing, testing and proving is the NRM *Induction Heated* Extruder we now make available to the plastics industry. Here are some of the basic details . . .

2889



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the perfect plastic for skin or blister packaging. JODA extruded acetate sheets, rolls and film in light to heavy gauges—transparent, translucent or opaque—excellent for vacuum forming.

BUTYRATE and LINEAR POLYETHYLENE available in standard sizes.

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JOSEPH DAVIS PLASTICS CO.

The illustration shows a blister package made of JODA crystal clear acetate by Rel Manufacturing Corporation.

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Out-produce other machines with TWICE the rated capacity

The Moslo Model 74—2 ounce automatic injection molding machine.

It is absolutely a fact—you can run molds on a Moslo machine at twice the capacity. This statement is backed up by the production records of many satisfied users of Moslo machines.

Whether you are making SHORT or LONG runs this Moslo machine will make greater profits for you. It will accommodate any standard mold, has a greater plasticizing capacity, and will inject more material into the mold and eject the part faster, than any other comparable machine. Ideal for running Nylon as well as other thermoplastic materials.

In order to fully appreciate how a Moslo machine can benefit you visit our Cleveland headquarters. Bring your own molds and we will demonstrate exactly what a Moslo machine can do for you. Let us hear from you and we will be glad to arrange an appointment.

The Moslo Model 75—4 ounce automatic injection molding machine.

MOSLO—The Name for the world's fastest Molding Machines

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A full line of components and complete installations available for sheet, film, pipe and profiles. If you face a problem in extrusions, call on Egan. Our staff of plastics specialists, engineers, and technicians is ready to serve you.

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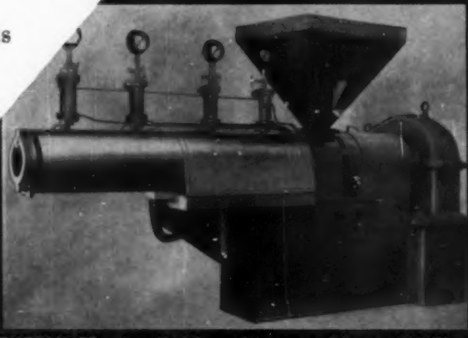
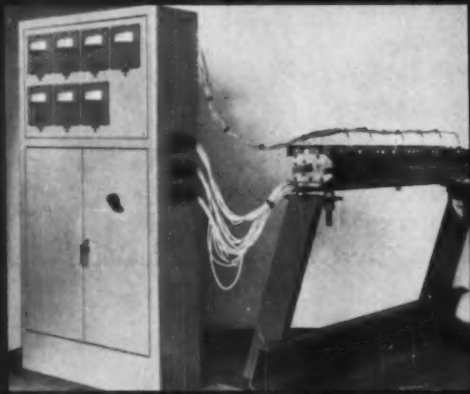
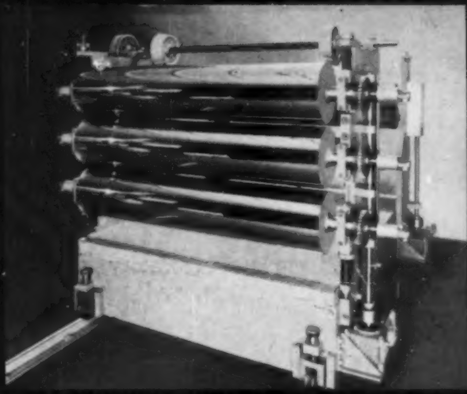


EXTRUDER: Available with or without "Willert Temperature Control" system. Willert system provides automatic, balanced temperature levels. Egan extruders, with patented features, designed to meet any requirements.



SHEET EXTRUSION DIE: Manifold type, adjustable die opening for thicknesses to ¼", completely pre-wired temperature control panel.



SHEET FINISHING UNIT: Three highly polished, chrome plated, double shell finishing rolls; rubber covered pull rolls, variable speed drive.

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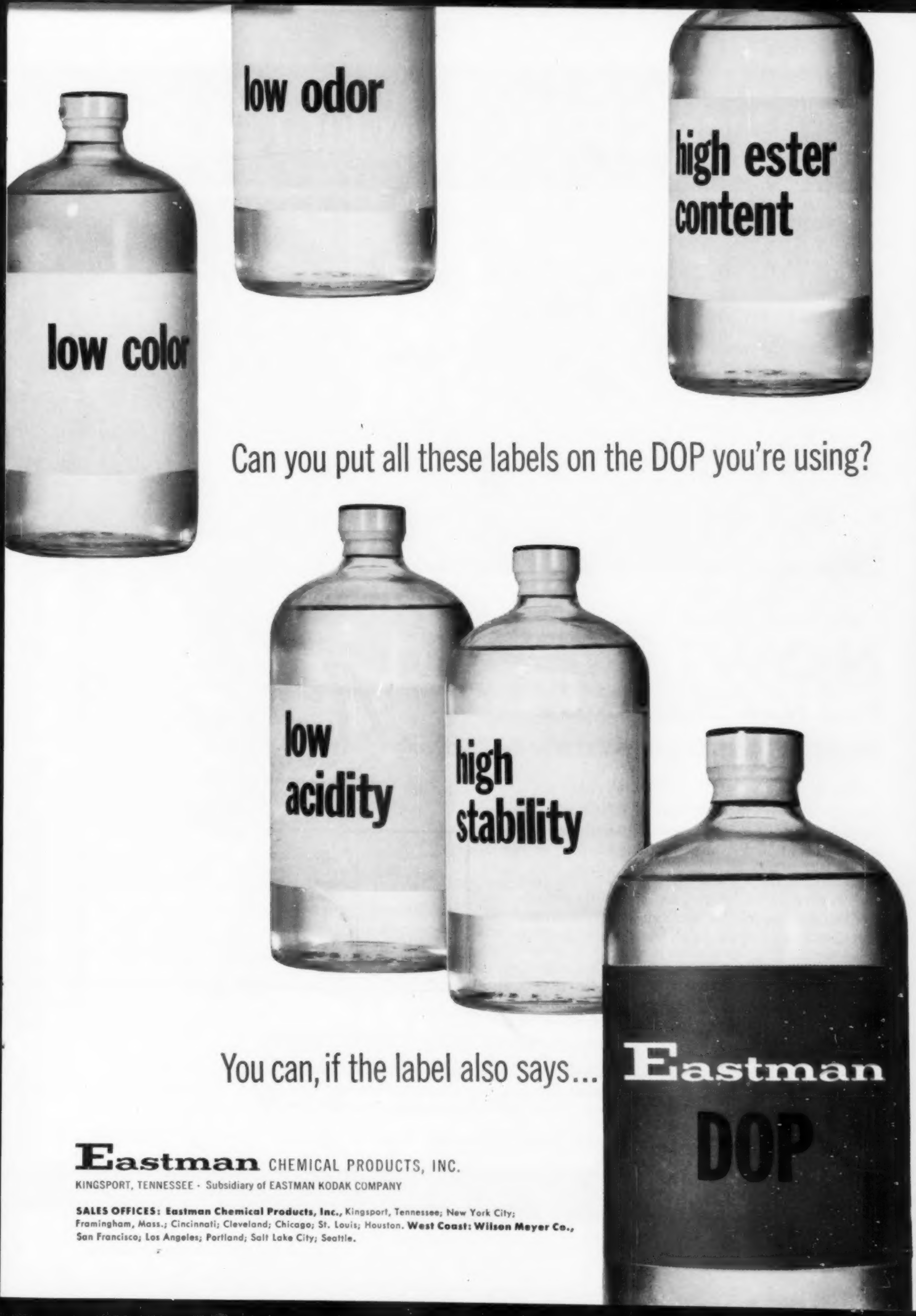
low odor
high ester content
low color
Can you put all these labels on the DOP you're using?
low acidity
high stability
You can, if the label also says...
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DOP
Eastman CHEMICAL PRODUCTS, INC.
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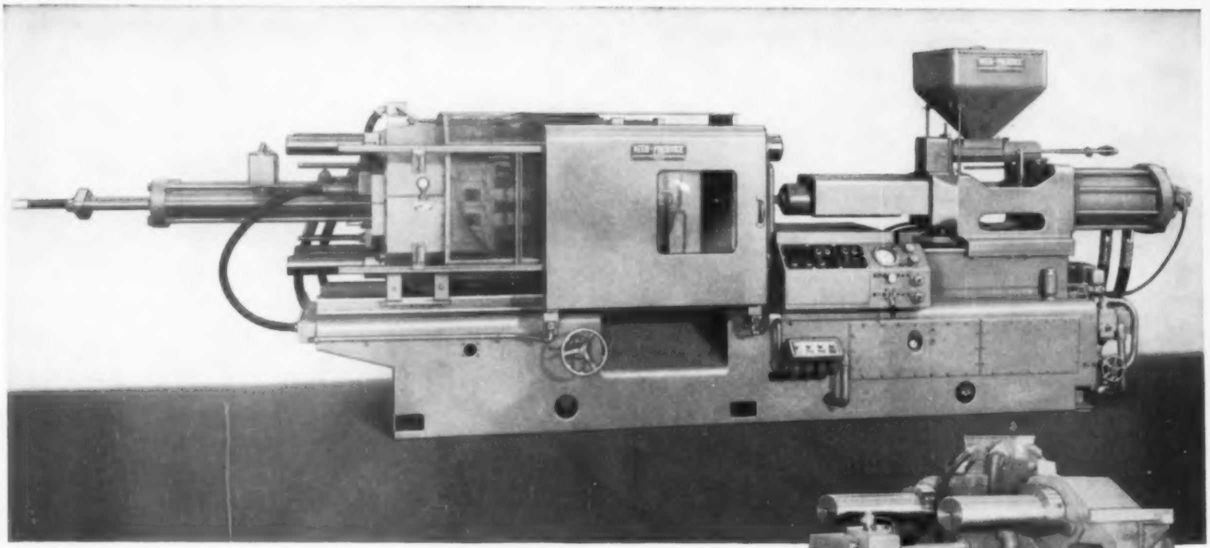
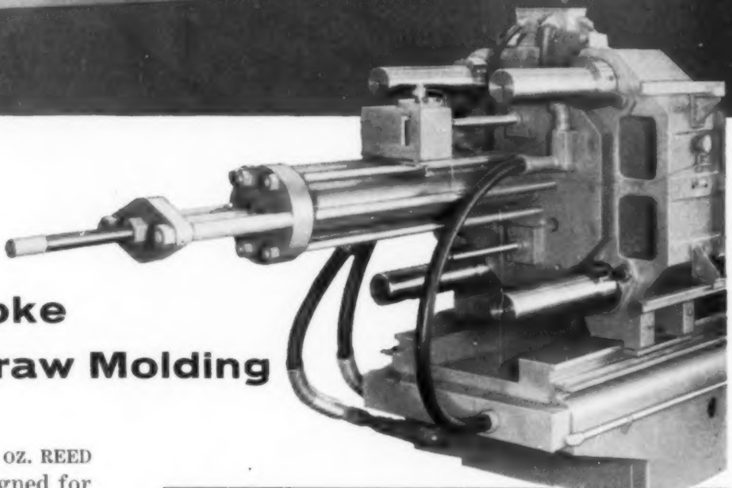
Engineered for Modern Molding





NOW!

Two New Long Stroke REEDS for Deep-Draw Molding

New 175TL–4/6 oz. and 300TL–12/16 oz. REED injection machines are specifically designed for deep-draw and container molding.

Both models have a completely redesigned link end to give you a longer, more flexible adjustable mold clamping stroke. You get more than a 50% increase in mold depth and greater locking tonnage.

An optional low pressure die closing arrangement prevents damage to the mold in the event a molded piece fails to eject while the machine is running automatically.

Through multiple injection strokes, a built-in stuffing arrangement permits increased injection capacity in each model.

	175T 4/6 oz. Standard	175TL 4/6 oz. Long Stroke	300TA 12/16 oz. Standard	300TL 12/16 oz. Long Stroke
Adjustable Stroke	5" to 8"	6" to 12"	7½" to 12½"	8½" to 20¼"
Maximum Depth of Molded Part	4"	6"	6"	10"
Dry Cycle Time, Seconds	5.7	7.2	10	12

Centrally located machine controls place the entire operation at the operator's fingertips. Die space adjustments are by hydraulic rather than mechanical means. This makes mold setups and space adjustments faster and easier.

...NEW, LONG STROKE REEDS

M.C.I. Plastics typifies the trend toward modern molding methods. Mr. Hartung's ideas on automation have made his plant one of the country's most modern in less than a year. He is presently operating three 175T—4/6 oz. and four 300TA—12/16 oz. REEDS, and has started construction for increased floor space and molding capacity to be completed this year.

"FOR AUTOMATIC MOLDING, WE USE REEDS EXCLUSIVELY"

SAYS RICHARD HARTUNG,
President of M.C.I. Plastics in Lakewood, N. J.

"We now produce over 20 million flower pots a year, and expect to increase capacity greatly this year. As far as I'm concerned, automatic molding is the only way to maintain a high volume at minimum cost and space, and with machine-controlled high quality. But the injection machines have to be rugged to stand up to such a grind. That's why I'm a solid REED user. Right now we're running all 7 REEDS automatically, at high speeds. My entire production is handled by 4 men whose main jobs are to keep the hoppers filled and remove cartons of finished products. My maintenance costs are extremely low, and on the rare occasions when I do need service, I can get a REED representative at a moment's notice."

Modern Molding DEMANDS Modern Equipment

Yesterday's molding machines just weren't built to handle today's production. They haven't the durability or the speed to stand up to the continuous automatic operation you need to maintain a competitive price. But new REEDS are designed with an eye to future molding. Not only will they boost output and cut production costs, but they will continue to keep your profits at a high level.

It costs you nothing to find out how much you can save by investing in new REED equipment.

A Free Mold Test in our modern laboratory will determine the full efficiency of your present molds under actual production conditions.

A Free Production Survey by a trained Reed-Prentice sales engineer will show you in full detail how much you can improve your present production with new REED equipment.

For information about any of these services call the nearest Reed-Prentice sales enginer. He can show you a complete line of injection equipment from 4 oz. to 32 oz. capacities. If you prefer you may write directly to our main office in Worcester.

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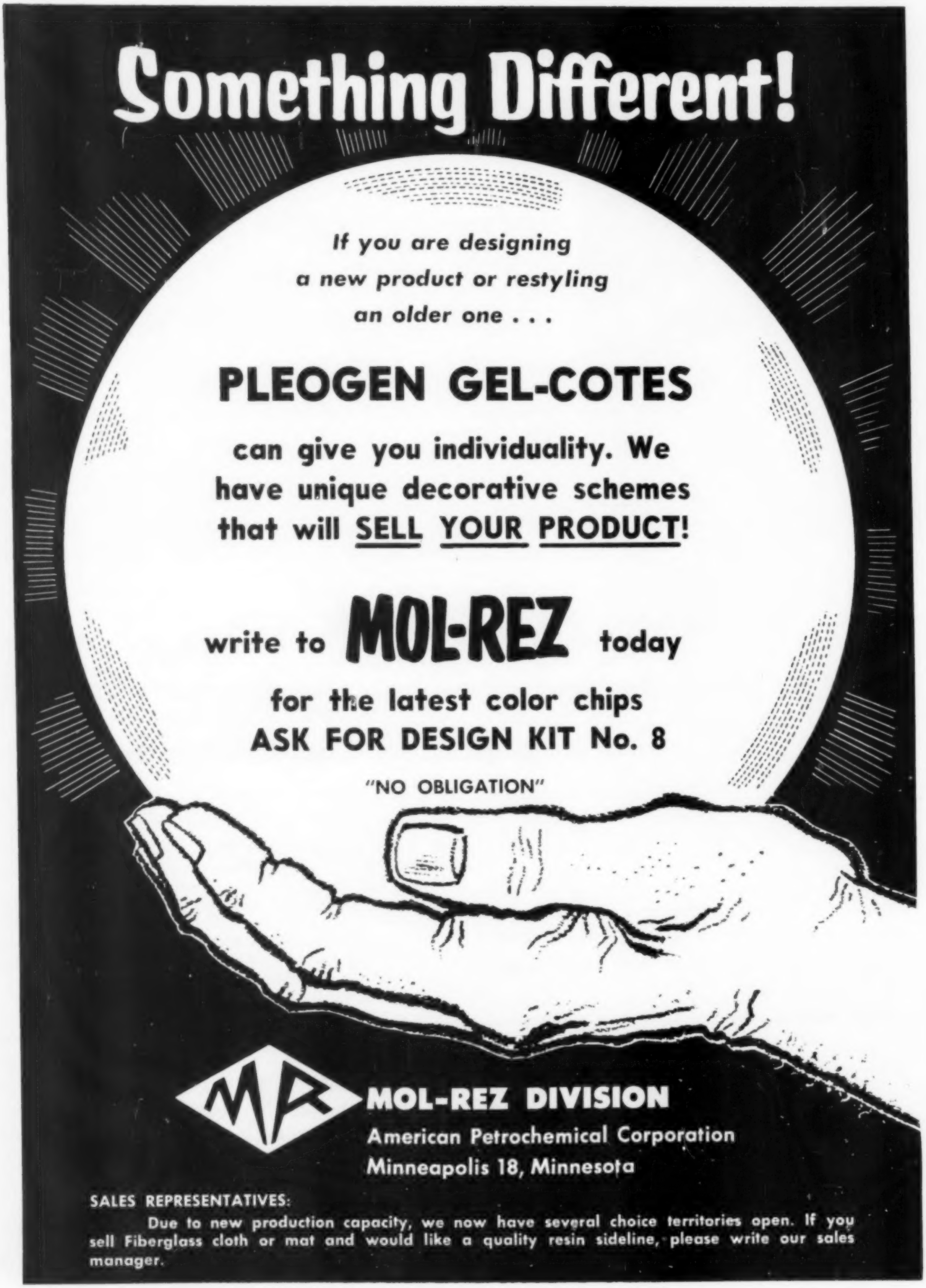
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Due to new production capacity, we now have several choice territories open. If you sell Fiberglass cloth or mat and would like a quality resin sideline, please write our sales manager.


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NOW...TWO modern plants to produce your custom molded plastics Efficiently... Economically... On Time!
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VACUUM CLEANER NOZZLES
CASH REGISTER DRAWERS
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in which is located General Industries' sales, engineering and mold making departments, together with its extensive facilities for compression and transfer molding of thermosetting materials.
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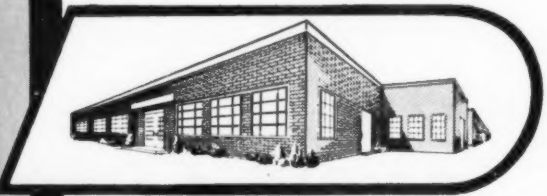

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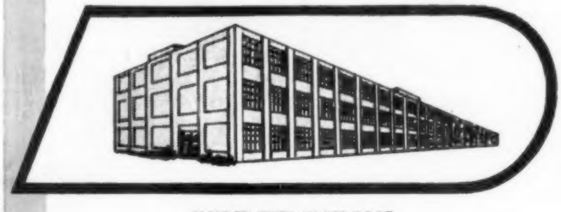

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The world's largest commercial plant to produce polypropylene is now on stream. Pro-fax, Hercules polypropylene, is the most significant new plastic to be developed in years. It has a lower specific gravity than any other plastic material commercially available. Pro-fax has higher tensile strength, hardness, heat resistance, stiffness, resilience and clarity, coupled with the inertness and water resistance typical of a hydrocarbon polymer. Pro-fax is exceptionally easy to mold, yielding parts with a hard, glossy surface available in a broad range of colors.

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Pro-fax is the Hercules trademark for polypropylene, a hydrocarbon polymer, based on propylene and a new Hercules process. Pro-fax will complement the usefulness of Hi-fax®, Hercules high-density polyethylene, greatly broadening the available markets for plastics, especially those now served by wood and metal.

Pro-fax is the second of many new polymers resulting from a Hercules research program designed to explore the chemical horizons opened by the development of organometallic catalysis systems. Others will follow as Hercules continues its leadership in the important field of polyolefin chemistry.

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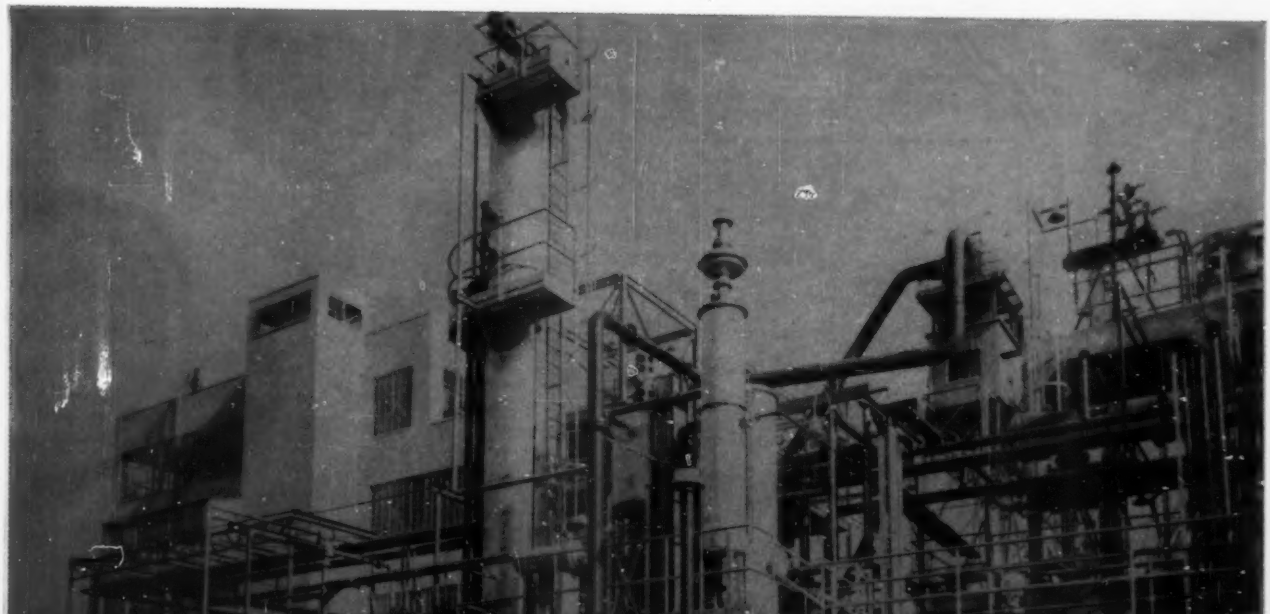
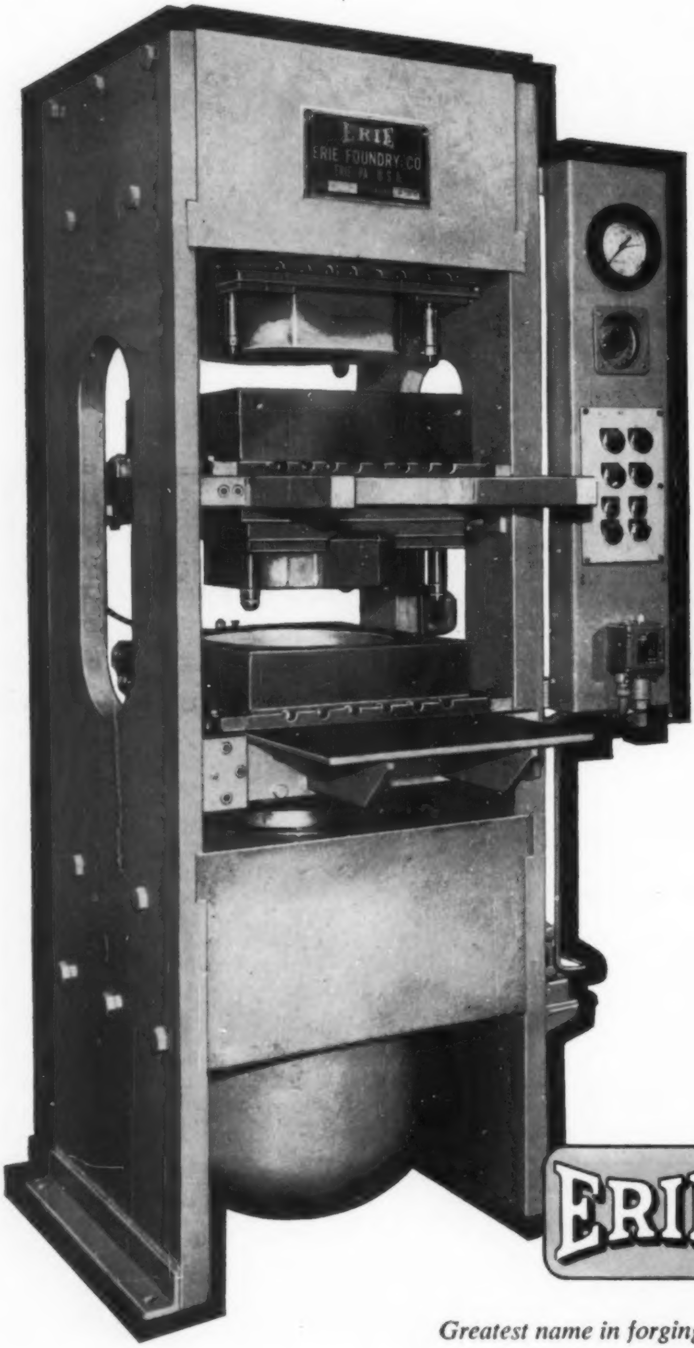
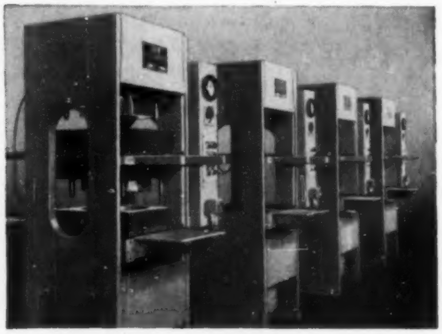


this ERIE press "stands out" for low-cost molding



If you're molding plastics or thermo-setting materials, you can boost profits by including Erie presses like these in your operation. Of side plate construction, with two 15" openings, this machine is up-acting, has a 14" main ram with a 16" stroke.

Semi-automatic in operation, this Erie press features a die-slide arrangement and accurate action that holds scrap loss to absolute minimums. Low maintenance costs and overall savings in operation make these presses ideal for any compression molding operation.



The battery of presses shown above is employed in a precision plastics operation (the owner commented, incidentally, that they are "performing better than the manufacturer stated"). This battery is powered by a high and low pressure accumulator system which was built by Erie Foundry. The presses are available with self-contained pumping units.

We'll be glad to give you full details on this press. Or let us help you with any press problem. There's no obligation. Just call or write...

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MODERN PLASTICS
Volume 35
January
1958
Number 5

Don't miss...

The first in our new series of covers. For the first time in its 35 years of existence MODERN PLASTICS goes to full-color covers. Three top-notch and internationally recognized cover artists are involved in the 1958 series. This, the first, is by Robert Hallock. It is designed to express the theme of this issue—growth—plus the new world significance of plastics as materials involved in upgrading world standards of living.

For those readers who may be confused by the "orange peel" presentation of the map of the world we hasten to point out that this is a post-satellite map. And when the moon is reached, if any plastics raw materials are found on it, MODERN PLASTICS will try to peel it for its readers, too!

Markets for materials—1957. Now well past the four billon pound mark, plastics materials are breaking into new avenues of consumption and new marketing patterns are being established. Article begins on p. 83.

How many machines were sold? The 1957 statistics on sales of processing machinery will be found on p. 143.

New trends in plastics applications. Advances in 1957 were made along a broad and fluid front in already developed markets. There were few revolutionary new products, but certain fields such as building construction, agriculture, and transportation show promise of increasing plastics consumption tremendously. Research work in the missiles field is resulting in completely new approaches to heat resistance in plastics. New materials coming on the market and new processing techniques are already lending a glow of optimism to the prospects for plastics applications in 1958. See "Significant trends," p. 106.

Where do we go from here? Trends in plastics usage are becoming clearer after a year of expansion on previously established bases of application. The whole industry stands on the threshold of a breakthrough into new markets. Eight major material groupings are here reported on and the prospects analyzed. They are as follows: phenolics, p. 85; urea and melamine, p. 91; cellulosics, p. 92; acrylics, p. 94; polystyrene, p. 95; vinyl chloride, p. 97; polyethylene, p. 101; nylon, p. 105.

Are you behind on your plastics reading? Are you looking for new information in your field? All significant material published in 1957 will be found in synopsis form in "1957 Highlights," starting on p. 117, and in review form in "The year 1957 in review," starting on p. 153.

S.P.E. 14th Annual Technical Conference will be the biggest ever. The timetable, program, and abstracts of all papers are presented beginning on p. 144.

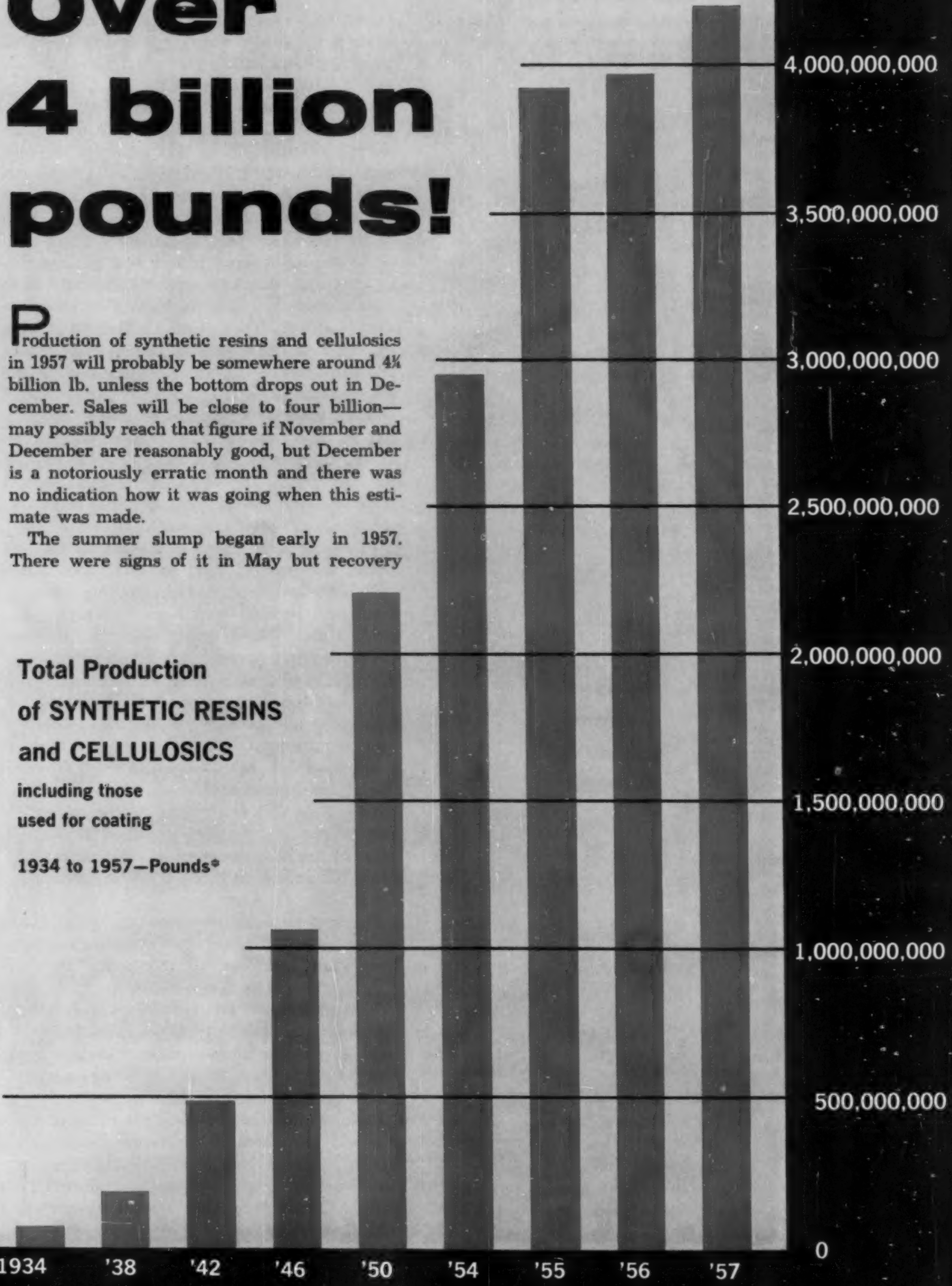
Watch for... our continuing series of full-color covers! Artists Robert Hallock, Clarence Carter, and Weimer Purcell are working on this series, each of which will be reflected editorially in a short statistical presentation of the service of plastics in the field or industry represented by the cover. Here is the cover schedule: February, the burgeoning market for reinforced plastics; March, plastics applications in the toy industry; April, plastics in agricultural applications; May, plastics in packaging; June, how plastics are used in furniture; July, plastics in housewares; August, the boot and shoe industry and its plastic applications; September, plastics premiums; October, the automotive market for plastics; November, the National Plastics Exposition issue; and December, plastics in building construction. . . .

. . . a complete picture of plastics boat manufacture with photographic essays of boat making methods, from 9-ft. dinghies to 36-ft. landing craft . . . the story of plastics in tarpaulins, airhouses, and Dew Line radar huts . . . a continuation of our series on the economics of extrusion, embracing unusual applications of the extrusion process . . . one or more articles on plastics in missiles involving previously classified information concerning heat-sink or ablative materials . . . a thorough coverage of NEW applications of plastics in the electronics field . . . new applications and methods for fabricating vinyl-metal laminates . . . a series of articles on plastics pipe . . . the introduction of slush moldable and rotationally castable polyethylenes . . . an analysis of the potentials in reinforced thermoplastics . . . and much more about new materials, new methods, and new markets!

Over 4 billion pounds!

Production of synthetic resins and cellulosics in 1957 will probably be somewhere around 4¼ billion lb. unless the bottom drops out in December. Sales will be close to four billion—may possibly reach that figure if November and December are reasonably good, but December is a notoriously erratic month and there was no indication how it was going when this estimate was made.

The summer slump began early in 1957. There were signs of it in May but recovery



Total Production of SYNTHETIC RESINS and CELLULOSICS

including those used for coating

1934 to 1957—Pounds*

*Source: U. S. Tariff Comm. and MODERN PLASTICS estimates.

Sales in pounds of synthetic resins and cellulosics, including surface coatings, in 1957[a]

Cellulose plastics		
Cellulose acetate and mixed esters		
Sheets under 0.003 gage	19,600,000	
Sheets 0.003 gage and over	18,200,000	
All other sheets, rods, and tubes	7,000,000	
Molding and extrusion materials	95,300,000	
Total		140,100,000
Nitrocellulose sheets, rods, and tubes		4,100,000
Other cellulose plastics, primarily ethyl cellulose		5,000,000
Phenolic and other tar-acid resins		
Molding materials	182,000,000	
Laminating resins[b]	64,000,000	
Abrasives	16,800,000	
Friction materials, brake linings	16,000,000	
Plywood	36,000,000	
Thermal insulation binder	48,000,000	
All other bonding resins	34,000,000	
Protective coatings	26,000,000	
Miscellaneous	34,000,000	
Total		456,800,000
Urea and melamine resins		
Textile-treating and textile-coating resins	35,000,000	
Paper-treating and paper-coating resins	26,000,000	
Bonding and adhesive resins for plywood	94,000,000	
All other bonding, including laminating	28,000,000	
Protective coating resins, straight and modified	29,000,000	
Resins for all other uses, including molding	100,000,000	
Total		312,000,000
Vinyl resins		
All types, including chloride, saran, butyral, polyvinyl acetate		810,000,000
Styrene type resins		
Molding materials	400,000,000	
Other types, including coating resins	202,000,000	
Total		602,000,000
Alkyd and rosin modified coatings[b]		495,000,000
Coumarone-indene and petroleum polymer resins		270,000,000
Polyesters		86,000,000
Polyethylene		630,000,000
Miscellaneous types		180,000,000
Grand Total		3,991,000,000

[a] Source: U. S. Tariff Commission, first eight months; last four months estimated.
[b] Production figure used because of large percentage of captive plants.

began early—in August. October was an exceptionally good month. If it hadn't been, all plastics except polyethylene and vinyl chloride would have been under 1956.

However, the worst slumps of all were in alkyds and rosin-modified esters. Alkyds were down 100 million lb. in 1957 from the previous year. Incidentally, alkyd sales in the MODERN PLASTICS tabulation at the left are carried at about the same figure as production since much of it is used by the company manufacturing same and is not reported as a sale. If these two resins, plus coumarone-indene and petroleum resins are deducted from the total of sales, the new total would be around 3 billion 150 million lb. which is more truly a plastics figure since the afore-mentioned resins are not used in the plastics industry.

Vinyl chloride with sales of around 650 million lb. is still the largest volume of any plastic. In the table at left it is included in the figure for "all vinyls." Polyethylene is close behind with an estimated 630 million lb. but last quarter sales may raise the total.

Phenolics were the only plastics material in which the over-all total for 1957 was under 1956. Principal losses were in molding material, laminates, thermal insulation, and plywood—most of them due to a decline in the construction industry.

Polyesters were up about 15 million lb. from 1956, but the percentage used for reinforced plastics is not known. Adipic acid polyesters used for urethane, casting resins, and various other polyesters are included in the 1957 total of 86 million pounds.

The "Miscellaneous resins" category, which contains methacrylates, nylon, filled alkyds, and some of the silicones used in plastics were up about 12 million lb., thus reflecting primarily the growth of the first two.

Polystyrene molding materials were down somewhat but the total of all styrenes was up a trifle due to increases in "other resins" that are attached to that family.

Melamine, urea, and cellulosics were about the same as in 1956, with the production of dishware keeping melamine consumption at a high level. Cellulosic film and molding powders showed slight gains over 1956.

Sales of material for export is of significant size and may present future problems since foreign countries are now building huge capacities. Polyethylene export was around 170 million lb.; vinyl chloride around 40; polystyrene about sixty.

Markets for materials–1957

Phenolics

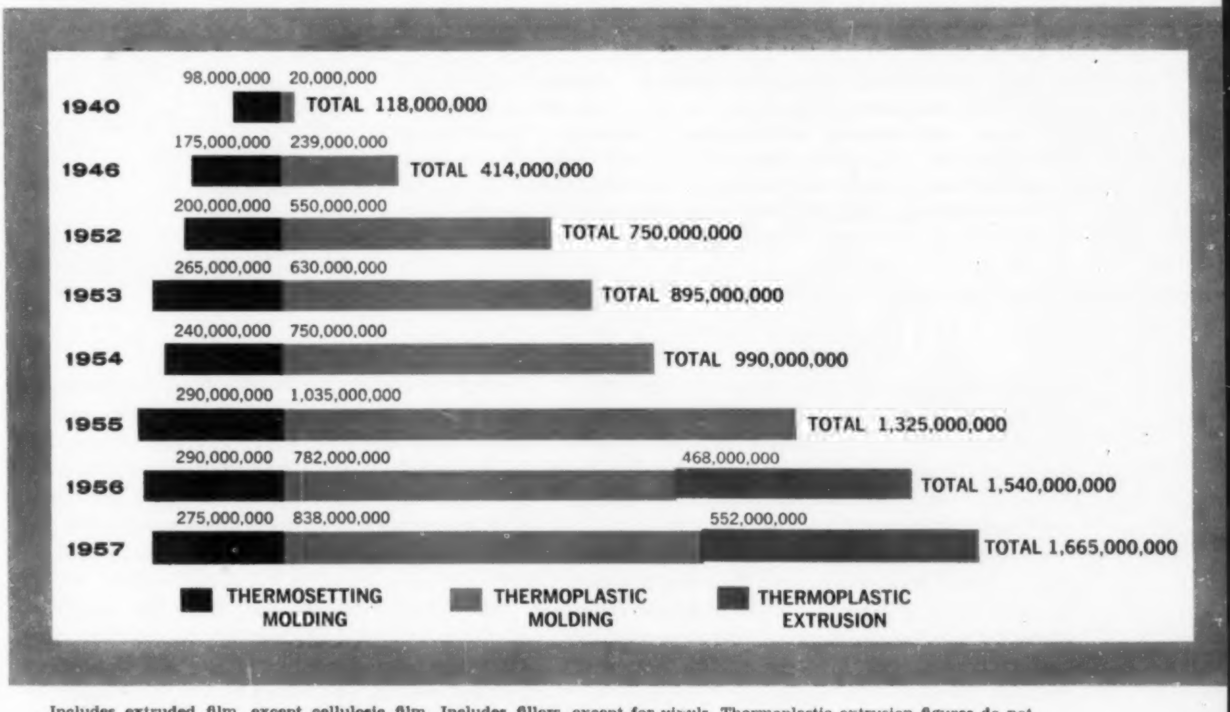
The froth and fuzz have worn off applications of phenolics. The cats and dogs have been eliminated. Producers believe that practically every use of phenolic today is based on the fact that phenolic is the most suitable material available from the standpoint of properties and economics. There are going to be many surprised people in the industry if any major phenolic applications are lost in the near future. Those that are going have gone. A few will decline somewhat in volume but they won't entirely disappear.

The phenolic molding powder industry has suffered severe fluctuations in the past, but the sales record now indicates a leveling off point at from 170 to 200 million lb. a year, with only mild fluctuations in the future. The 200 million lb. volume is not set as an upper limit, but increases are expected only as those industries which use phenolics expand and require more parts.

Of course, there is always the possibility that a new application such as furniture drawers will grow into big volume or that a new idea will take hold, such as the once-hopeful plan for chrome coated phenolic radiator grilles on automobiles. Or it may be that new resins will some day add volume to the industry. Such developments would be highly pleasing, but even without them the phenolics industry expects to ride on an even keel for years to come.

A significant development during 1957 was a molding powder which was claimed to reduce

Sales of molding and extrusion materials in pounds, 1940 through 1957



Includes extruded film, except cellulosic film. Includes fillers, except for vinyls. Thermoplastic extrusion figures do not include reprocessed material such as that used in pipe, garden hose, and film.
Figures are based on U. S. Tariff Commission reports, except for estimated last four months of 1957 and adjustments made in Tariff Commission Reports in "Miscellaneous molding" category.

1957—the record

PHENOLICS Molding powder showed decline from 204 million lb. in 1956 to around 180 in 1957. Producers feel that phenolic molding material may stabilize at somewhere near present figure. Items that can be molded from other materials are gone and items now molded from phenolic are secure because phenolic is best for the job. Industrial or liquid resins declined in laminates, plywood, and thermal insulation. Shell molding resins are beginning to show signs of sizable growth.

UREA AND MELAMINE Molding powder up from 90 million lb. in 1956 to 100 million, with melamine dishware given most of credit for increase although urea was also slightly ahead of last year. Dishware is expected to grow as much in 1958 as it did in 1957. New, fast-curing urea is thought to have helped the urea total. Glue for plywood was off considerably in 1957 due to serious decline in the hardwood plywood industry caused partly by foreign importation.

CELLULOSICS Acetate and butyrate continue to grow a few million pounds per year, with molding material volume now about 95 million lb. and bolstered by a 5 or 6 million-lb. shoe heel business. Fashion trends look favorable for acetate in 1958 in such items as beads, sequins, and perhaps lampshades which had given way to other materials. Increasing use of film, particularly as a wrapper, is encouraging to producers.

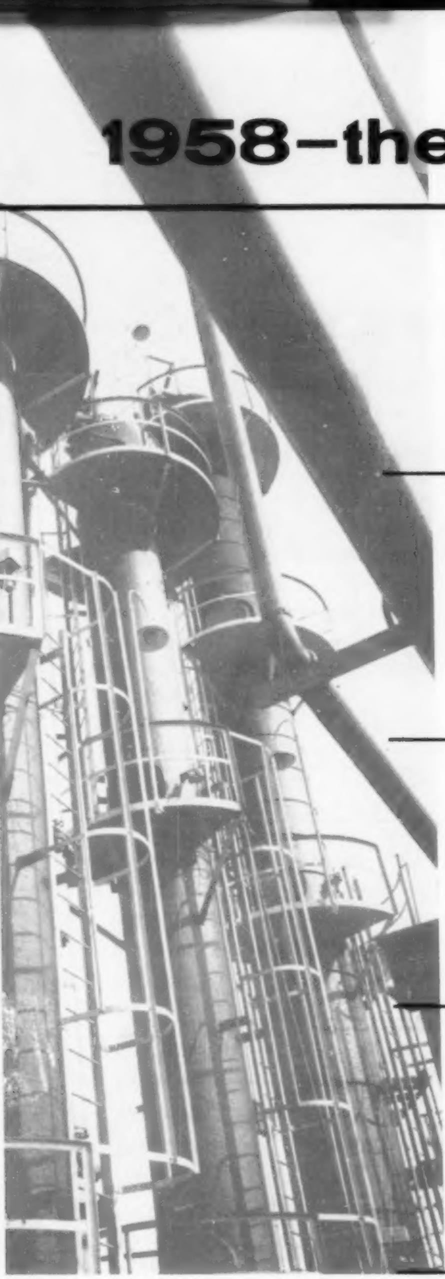
ACRYLICS There were moderate gains in methacrylate resins used for molding and sheet production in 1957. Interesting new developments were a new impact methacrylate, a monomer-polymer sirup for reinforced plastics, a molded monomer-polymer light diffuser with possible applications in other fields. Size of molded pieces for appliances, such as washing machine regulator, increased to a noticeable extent.

cure time by 50% and to be particularly suitable for electrical components. The new material was developed specifically for use in cold-powder automatic molding but may also be used in most types of compression molding equipment and can be preheated.

Color has always been one of the handicaps facing the phenolic industry. Two years ago it looked as though this problem might be overcome by the development of an epoxy coating that could be applied easily, at low cost, and without likelihood of chipping. Progress has been made but it is not yet sensational. Electric iron handles were suggested as a major item but such colored handles haven't swamped the market. An iron manufacturer at the housewares show had them almost hidden away on a back shelf; he said he didn't care for the inventory problem that colored handles presented. Perhaps a marketing program is essential in order to merchandise the potentialities of colored phenolic.

Low cost has always been a special property of phenolics, but last year the trend of nearly all other plastics was reversed and the price for all phenolics was raised by 1½¢/lb. General-purpose molding powder is now 21½¢/a pound. It isn't likely that the phenolic industry will

1958—the prospects



POLYSTYRENE Sales surprised all estimators late in 1957 with a last-quarter spurt that will probably put sales slightly over the 402 million-lb. mark in 1956. Early-fall estimates had indicated that polystyrene sales in 1957 would be less than in 1956 but October sales probably broke all records at over 40 million lb. and November was not too far behind. Replenished inventories after a year of hand-to-mouth buying, plus a better-than-expected fall season in refrigeration and consumer items, is believed responsible for the upsurge.

VINYL CHLORIDE Increased sales volume by from 70 to 80 million lb. in 1957 over 1956, which is close to the almost unbelieveable 100 million-lb. increase in 1955. Every classification benefited from the upsurge, with particular emphasis on floor coverings, film and sheet, molding, and extrusion. Plastisols increased steadily but no accurate figures are available. Film and sheet laminates have added new breadth to industry base. Eight new companies entered the resin field. Capacity is about 200 million lb. ahead of consumption.

POLYETHYLENE Still climbing fast: there was a 140 million-lb. increase in 1955, 160 million in 1956, and 115 million in 1957. If increase continues at that rate for several years, consumption will be close to one billion lb. in 1960. Capacity of high-pressure plants will approach one billion lb. in 1960; low-pressure capacity will be 300 or 400 million. Film is largest-volume end product at around 200 million pounds. Polypropylene now in production in U. S. but price is higher than polyethylene.

NYLON Two new producers entered the field with nylon-6, produced from caprolactam. This is the type widely used in Europe. The producer of nylon-6/6 introduced new formulations, one of which is more weatherable than conventional nylon. Another is a better white for use in consumer items and a third is a high-viscosity extrusion material. There are now more than 600 molders prepared to turn out nylon parts, but about 80% of the business is handled by around 80 molders.

ever surrender its low-price advantage but it no longer can afford to lower the price because volume is constantly increasing.

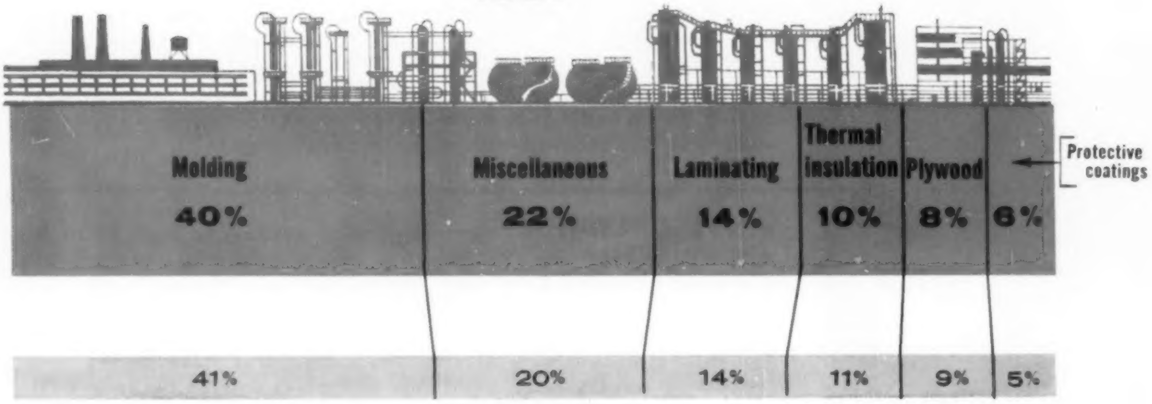
Durite, a long-time name in the industry, disappeared from the list when Borden (which purchased the Philadelphia company after the war) decided to close the shop.

The table on page 90 gives an idea of how various applications in the phenolic molding industry are progressing. The figures are estimates—no official tabulation is available—but they give an idea of how the industry divides up its various activities and how each item is expected to fare in the future.

The first two items give a clear picture of the importance of the **electrical industry** to phenolics. It is also evidence that phenolics have not gained much ground in electronics but must depend on the "old-fashioned" electrical industry which is still growing at a good rate. As long as new power plants are being built and more kilowatts are being produced there will be a demand for panel boards and switch gear, even though growth is not in astronomical figures.

Wiring devices such as switches, wall plates, sockets, and night lamps are in about the same position, but their growth is tied to construc-

Phenolic consumption by end uses



Phenolic resin sales[a, b]

Use	*1954* lb.	*1955* lb.	*1956* lb.	*1957* lb.
Molding materials	172,000,000	200,000,000	204,000,000	182,000,000
Laminating resins[c]	64,000,000	82,000,000	70,000,000	64,000,000
Abrasives	11,000,000	16,000,000	16,500,000	16,800,000
Friction materials, brake linings, etc.	15,000,000	22,000,000	16,000,000	16,000,000
Plywood	28,000,000	36,000,000	42,000,000	36,000,000
Insulation for rock wool, fibrous glass	37,000,000	52,000,000	55,000,000	48,000,000
All other bonding resins	13,000,000	27,000,000	32,000,000	34,000,000
Protective coatings	22,000,000	25,000,000	26,000,000	26,000,000
Miscellaneous	27,000,000	29,000,000	37,000,000	34,000,000
TOTAL	389,000,000	489,000,000	498,500,000	456,800,000

[a] Source: U. S. Tariff Commission, except 1957, which is estimated.
[b] All on solid resin basis, except molding materials, which includes about half filler.
[c] Production figure used instead of sales figure because there are so many captive plants. Suspicion is that figure could be 20% higher because of faulty reporting from some captive plants.

tion, particularly housing. There is competition here from urea and even molded vinyl in such devices as plugs and attachments, but the market for such products is big enough to support all of them.

Closures show no growth because of competition from other plastics, possibly even from aluminum. But the pharmaceutical and liquor trades are expected to rely heavily on phenolics.

One of the brightest spots in the phenolic outlook is in **handles and housings** for appliances. Sprayed-on color may help. Colored butyrate threatens to move in on such housings as mixers where no heat problem is involved. And there is still a possibility that phenolics may regain some of the television cabinet business since an unfortunate accident with a metal cabinet in Chicago last year created a stir concerning use of metal for such purposes.

Phenolic telephones will no doubt decline because of competition from colored thermoplastics but there will probably always be a demand for a large number of black phenolic telephones. They are claimed to be more serviceable in a factory and even in many homes;

a colored set often costs from $7.50 to $10 more than a black one.

Washing machine agitators are expected to decline because of change-over from wringer-type machines to automatic washer-dryers. Some automatics do not have an agitator and the others use a smaller size since smaller loads of clothing are handled by the machines.

Automotive use of phenolic has been reversed from a downward to an upward spiral in the last year or so because the voltage systems have been increased and the producers need more insulation properties.

The growth in **camera parts** is a surprise but is due largely to use of more cameras and larger parts.

Molded plastics drawers for furniture is still a tug-of-war between thermosetting and thermoplastic producers. One phenolic producer is confident that his material will eventually grow large in this field. There is at least one mold in existence for a 15 lb. job. Medium-size drawers will weigh about 8 lb. and the small ones from 5 to 6 pounds. There is a definite hope in the industry that the three-million-lb. figure for 1962 is a low estimate. The industry has been working on this development for many years and is not going to give up easily. One great problem is the variety of sizes required and the consequent number of expensive molds that must be built. However, there is some possibility that a measure of standardization can be initiated and thus pave the way for longer runs of a given size.

Not much information has been released this year on **rubber-phenolic resin** but a cutlery manufacturer is using it successfully for handles and the older use for insulated handles on lineman's tools is still in vogue.

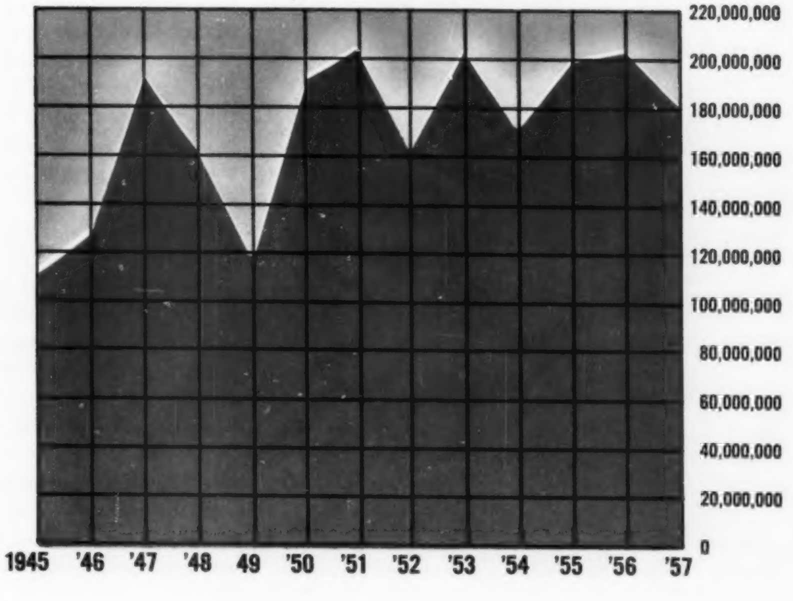
Fibrous glass filled phenolic is gradually picking up volume despite high cost. Transmission parts for automobiles is perhaps the most promising development in this category.

Phenolic resins other than molding material, generally called **industrial resins**, were off around 20 million lb. in 1957 from 1956. The general reason was that most of the industries that use them, such as steel and construction, were down somewhat in 1957.

When phenolic molding powder and industrial resins are added together the total is about 460 million pounds. The fact that pro-

PHENOLIC MOLDING POWDER

Sales in Pounds



PHENOLIC MOLDING POWDER END USE VOLUME

End use	1956 lb.	1957 lb.	1958 lb.	1962 lb.
Electrical controls (panel boards, switch gear, etc.)	38,000,000	36,000,000	37,000,000	39,000,000
Wiring devices	34,000,000	34,000,000	35,000,000	37,000,000
Closures	17,000,000	17,000,000	17,000,000	17,500,000
Utensil and appliance handles, knobs, bases, and housings	29,000,000	29,000,000	30,000,000	31,000,000
Telephones	6,000,000	5,000,000	5,000,000	4,000,000
Washing machines	11,000,000	10,000,000	9,500,000	8,500,000
Automotive	11,000,000	12,000,000	12,500,000	15,000,000
Vacuum tubes	6,000,000	6,000,000	6,000,000	5,500,000
Radio and TV condensers and resistors	2,000,000	2,000,000	2,000,000	2,500,000
Molded drawers	400,000	1,000,000	1,000,000	3,000,000
Camera parts	7,000,000	8,000,000	8,500,000	11,000,000
Buttons	500,000	500,000	500,000	500,000
Miscellaneous*	42,100,000	21,500,000	21,000,000	24,000,000
TOTAL	204,000,000	182,000,000	185,000,000	198,500,000

*Miscellaneous includes such things as caster wheels; textile machinery; office equipment; toilet seats; vaporizers; and exports.
NOTE: Figures are all rough estimates and are given to indicate applications which are expected to grow or decline.

ducers do not expect monumental growth is established by the estimate of one producer who is planning for a total of 560 million lb. in 1967. That is a good sound increase but of course not comparable to the growth expected from such plastics as polyethylene and vinyl chloride. Nevertheless, a 560 million lb. volume in 1967 will still find phenolics a major factor in the plastics industry. There probably won't be more than four or five plastics over the half-billion lb. mark even in 1967.

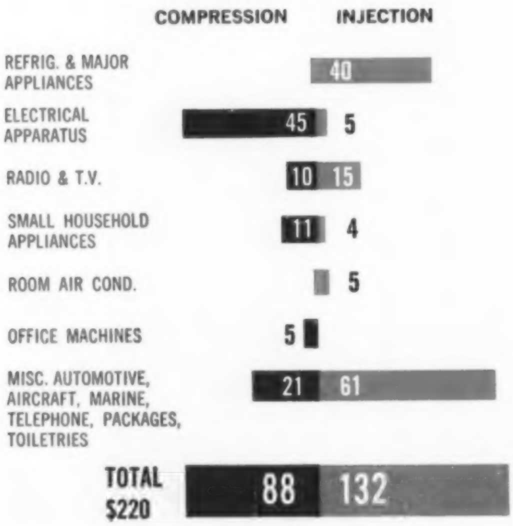
Abrasive resins held their own in 1957, possibly increased, because of changes in equipment design. Grinding wheels are bigger and abrasive felt now consumes more resin. Steel fabrication, where most of the equipment is used, was high in 1957 and automotive was slightly over 1956. The big jump upward in abrasives occurred in 1955, probably because of automotive uses, but it is encouraging to note that abrasive use has continued at even a higher level than in that record breaking year.

The figure on **friction materials** is murky because the Tariff Commission has dropped this classification and put it under "all other bonding resins." However, it is believed that the total is less than 1955 since most of this resin goes into brake linings for automobiles and naturally follows the same curve as the automotive industry.

Thermal insulation was down in 1957 because of the decline in housing.

All other bonding resins includes a whole host of things that are almost impossible to separate. Among them are impregnated battery separators which within a few years have become consumers of several million pounds of resin and are still growing in volume. Phenolic resin for particle-board bonding is on the upswing but growth is slow, partly because of the small amount of resin used per sq. ft. of

ESTIMATED U.S. CUSTOM MOLDING MARKET—1956 (IN $ MILLIONS)



board and partly because urea is still much more widely used. Some of the hardboards, which are thinner than particle board and are used in the furniture industry, also use phenolic.

Most interesting of the bonding resins are those used for **foundry shell molding.** They were sensationally boomed about 1951 as the coming biggest of all industrial (*To page* 193)

Urea and melamine

The steady growth of urea and melamine since World War II can be credited mainly to increased consumption by the textile, protective coating, chipboard, and other industries, rather than to any significant improvements of resins, advances in technology, or the development of new applications. The notable exception is in dinnerware, where more translucent materials, improved methods of decorating, and aggressive merchandising continue to extend the use of melamine molding compounds, particularly of the alpha-cellulose-filled variety. Urea and melamine still hold their own in an expanding economy despite competition from other materials, such as polyethylene and polystyrene in the closures field, for example.

The estimated urea and melamine figures for 1957 all run higher than Tariff Commission figures for the first eight months. The reason is that there are a number of small producers in the field who report on an annual rather than a monthly basis and their contribution will not be known until the Tariff Commission's Annual Report is published in mid-1958.

In 1957, melamine molding materials are thought to amount to about 49 or 50 million lb., or roughly 20% over last year's total. Dinnerware consumed about 90% of that amount, or some 36 million lb., which is very close to the total amount of melamine molding material thought to have been sold in 1956. There are now about 300 variations in colors and patterns of dinnerware available, decorated either by mixing two or more solid colors to produce a mottled effect; by using overlays or foils to produce multi-colored designs, even on compound

UREA AND MELAMINE RESIN SALES[a]

Uses	1954 lb.	1955 lb.	1956 lb.	1957 lb.
Textile treating and textile coating resins	39,000,000	41,000,000	40,000,000	35,000,000
Paper treating and paper coating	20,000,000	23,000,000	25,500,000	26,000,000
Bonding and adhesive resins for:				
Plywood	75,000,000	94,000,000	102,500,000	94,000,000
All other bonding and adhesive uses[b]	24,000,000	28,000,000	24,000,000	28,000,000
Protective coating resins, straight and modified	22,000,000	29,000,000	29,000,000	29,000,000
Resins for all other uses, including molding[c]	66,000,000	86,000,000	90,000,000	100,000,000
TOTAL	246,000,000	301,000,000	311,000,000	312,000,000

[a]Source: U. S. Tariff Commission, except last 4 months of 1957, which are estimated.

[b]This figure includes resin used for chipboard, melamine laminates, and commercial glue.

[c]Includes filler for molding material. The total for 1957 is thought to include 45 million lb. of melamine molding material, 50 million lb. of urea, and 5 million lb. of miscellaneous.

curves, which simulate porcelain (see "The Schlitztap," Modern Plastics 35, 122, Sept. 1957); or by molding color on color to achieve a two-tone effect. The latter process is a molding science in itself, but resin manufacturers, machine designers, and molders work closely together to improve decorating techniques and stimulate consumer demand for these virtually unbreakable dishes.

New **fast-curing ureas** are exemplified by American Cyanamid's U-50, developed for molding small objects such as closures, buttons, knobs, and other items where automatic machines are used, and U-40 which has a softer flow and is suitable for slightly larger objects. These materials have significantly contributed to the growth of urea molding compounds, especially since they are priced the same as regular materials—around 34¢/lb. Urea molding powder use declined in 1955, came back in 1956, and grew to about two to three million lb. in 1957.

Closures still grow steadily and, although polyethylene and polystyrene challenge urea in many applications, the closure market seems to have increased sufficiently to offset losses of such markets as toothpaste caps. The total consumption for closures made of urea was an estimated 15 million lb. in the year 1957. In the industry, there is a gen- (*To page* 196)

Exports relating to plastics (in millions of pounds)

Materials exported	*1956*	*First 8 mo. 1957*
Benzol and benzene (million gal.)	2.7	1.4
Phthalic anhydride	6.5	12.7
Urea and melamine plastics	17.8	13.7
Cellulose acetate molding material	8.0	5.5
Cellulose acetate plastics for other uses	10.6	7.9
Vulcanized fibre	6.8	4.2
Styrene polymer and copolymer resins	57.9	43.1
Vinyl and vinyl copolymer resins, uncompounded	33.7	20.8
Vinyl and vinyl copolymer resins, compounded	13.7	10.4
Resins not otherwise classified[a]	163.6	154.0
Laminated and molded not otherwise classified	4.9	3.3

[a] Major portion is polyethylene

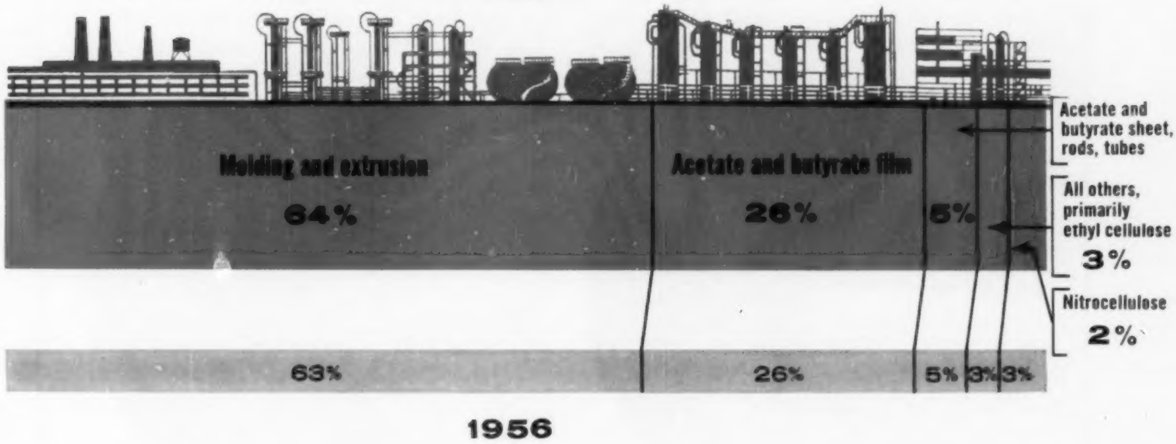
Cellulosics

Business is good—sentiment is bad, reported an acetate material salesman last fall as he told how a customer cried in his beard at the same time he was ordering more material than he had the year before. All year long the plastics industry, as well as many other branches of American enterprise, have witnessed this strange phenomenon that could be likened to a man who bet on a winning horse, but can't understand why he didn't collect more money at the pay-off window. Perhaps this sentiment helps explain why there has been so much conflicting opinion on the state of the plastics industry and why it is impossible to give a clear-cut opinion on the rate of progress.

The cellulosics, for example, may not have shown spectacular growth but there was no sign of a decline. The molding section of the cellulosics branch has increased sales volume from 75 million lb. in 1954 to over 90 million in 1957. That is a right respectable growth for a business that was supposed to be on the decline only a few years ago. It is not up to the growth pattern of the more spectacular thermoplastics but producers do not expect sensational performance from a material that has been around since the early 1930's.

New applications for a material that has been in use that many years are few and far between and an occasional loss of a product to newer plastics is to be expected in this chemical age of constant change, rapid turnover, and changing price structures. Dolls, for example, which once consumed 8 or 10 million lb. of cellulosics have turned to vinyl plastisols not only because the plastisols offer more desirable properties but also because hair styles in dolls have changed. Saran hair is now injected into doll heads like bristles in a toothbrush and such an

Consumption of cellulose plastics



Cellulose plastics sales, 1954-1957[a, b]

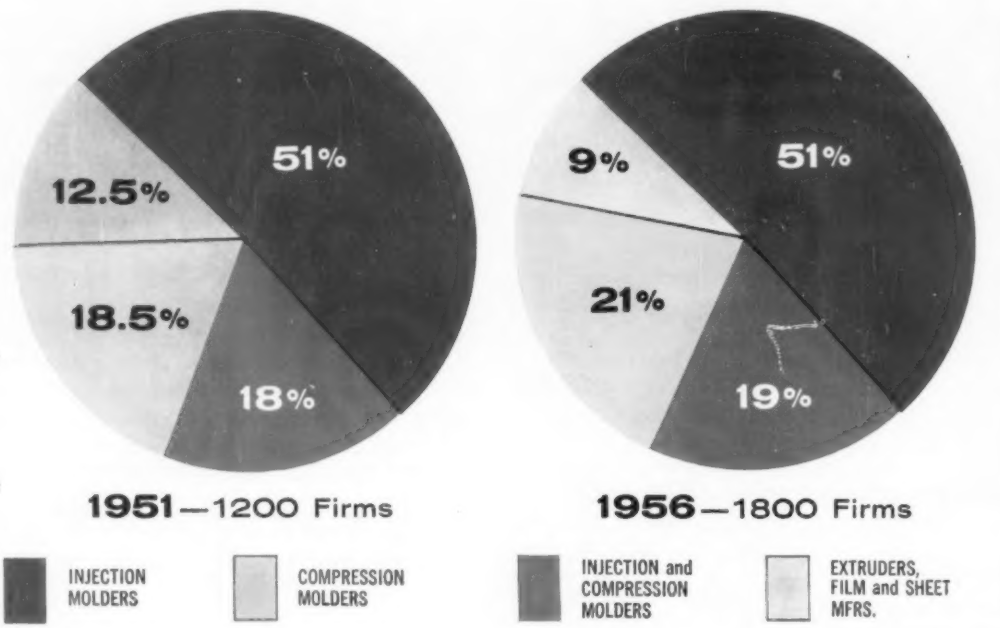
Classification	1954 lb.	1955 lb.	1956 lb.	1957 lb.
Cellulose acetate and cellulose acetate butyrate sheets:				
under 3 mils	17,500,000	19,000,000	19,400,000	19,600,000
3 mils and over	12,400,000	15,000,000	16,700,000	18,200,000
All other sheets, rods, tubes	5,300,000	7,000,000	7,000,000	7,000,000
Molding and extrusion materials	75,500,000	90,000,000	92,800,000	95,300,000
TOTAL	110,700,000	131,000,000	135,900,000	140,100,000
Nitrocellulose: sheets, rods, tubes	4,900,000	5,100,000	5,300,000	4,100,000
Other cellulose plastics, primarily ethyl cellulose	5,000,000	5,400,000	5,600,000	5,000,000

[a] Source: U. S. Tariff Commission, except 1957, which is estimated.
[b] Includes plasticizers, fillers, and extenders.

operation seems to be impossible in acetate or butyrate. Hobby toys in kit form—such as boats and planes which are assembled by the purchaser—have largely been taken over by polystyrene which is less costly. Butyrate pipe, which looked so promising a few years ago, is at a standstill while pipe producers experiment with various other plastics and wait for aging results on pipe lines that have already been installed.

Telephones are one of the applications which prove that cellulosics can find new outlets even though they have been around a long time. Poundage has grown yearly for the past four years, with continued increases expected. Up to this year butyrate was the only cellulosic used for this purpose, but Celanese propionate (Forticel) is now moving into the field and Eastman Chemical is also about to announce a propionate which it produced during the war years and then discontinued. Various other thermoplastics have been tested for telephones but so far have not been adopted. It is quite probable that the new polyolefins will be tried

Make-up of the U.S. plastics industry by processes



in this field but as yet they are still experimental.

Shoe heels in both butyrate and acetate are other new uses for cellulosics that started off with a bang in 1956 but probably failed to achieve the hoped for 6 or 7 million lb. in 1957; total consumption was somewhere between 4 and 5 million pounds. As usual with almost any new product, some snags developed but the shoe heel market seems definitely established. Butyrate is claimed to be easier to mold for this purpose than acetate, but the price differential is all in favor of acetate.

Butyrate is still going strong in automotive uses such as push buttons, knobs, and steering wheels. Other materials have been trying to steal this market for years but butyrate is still dominant, partly at least because it has the elongation (stretchability) necessary for the job. Extruded butyrate film for vacuum formed blister packaging and fabricated signs for outdoor use are still growing but volume is small compared with molded items. Metallic yarn is another market for butyrate film, but the producers are not mentioning volume now; Forticel, as mentioned earlier, moved into the telephone field in 1957 and it is expected that the propionates will eventually obtain half of that market. Mechanical pens and pencils are other markets where Forticel is a heavy contender. It is under test for automobile steering wheels; it has elongation akin to butyrate.

Acetate, butyrate, and propionate molding and extrusion material sales (*To page* 198)

Acrylics

Three events in the methacrylate field last year were at least among the more interesting developments of the plastics industry, even if they were not among those that caused the greatest commotion.

One was the development of Implex, an impact methacrylate to sell at about the same price as standard methacrylate. It was probably developed particularly for the shoe heel busi-

ness. Methacrylate was the first plastic to be used in shoe heels, but was difficult to nail without splitting. Implex overcame that problem and is lower in cost than butyrate, which had started to move in. But Implex will probably be found in many other applications as soon as there is enough of it on the market. It will undoubtedly compete with impact styrene where a glossy surface is desired and the cost can be carried. Because it resists ink it is a natural for business-machine keys, mechanical pens and pencils, and a whole host of applications now sought for by impact styrenes and the older 40 to 70¢/lb. plastics.

Second item of more than passing interest in 1957 was the development of a so-called monomer-molding process by a firm in Baltimore which is producing a stylized version of the so-called egg-crate type light diffuser. The material used is a slurry of methacrylate monomer and polymer poured into a low-cost aluminum mold under very low pressure. It is believed to be a practical, low-cost operation that can be applied to many other products when it has been fully developed.

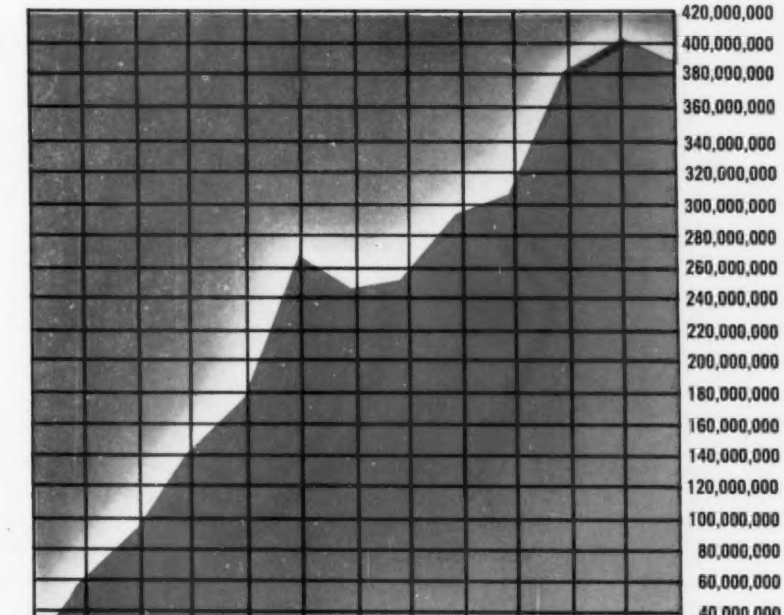
Third was the official announcement that a methacrylate "sirup" was ready to take the place of or supplement polyesters in reinforced plastics laminates. It is a par- (*To page* 200)

Polystyrene

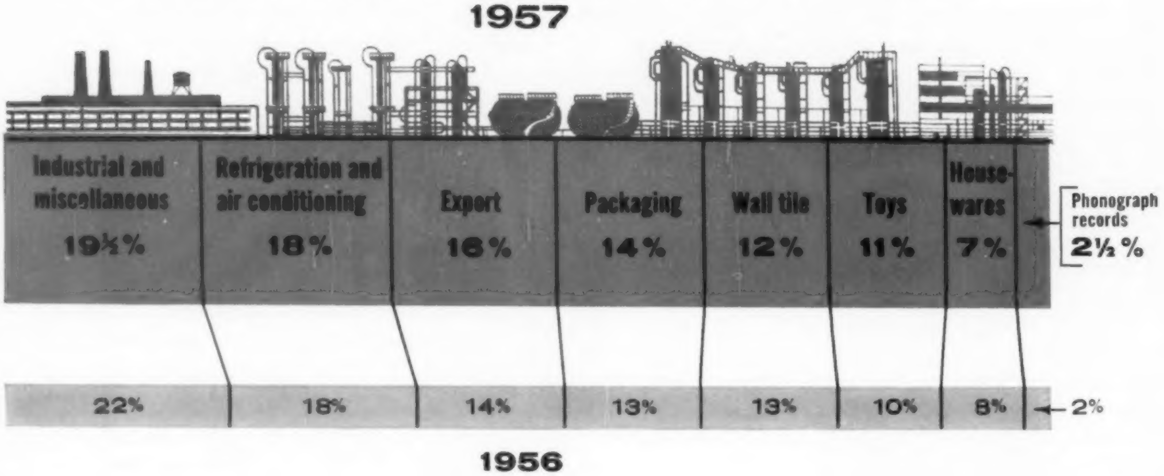
If polystyrene turns out to be a good fourth-quarter performer in 1957, the industry may have a good year despite the miserable months from May through August when sales were running from 24 to 33 million pounds. The industry hadn't had a month as low as 24 million lb. since the summer of 1954 and the slump was even more heart-breaking because it followed

STYRENE-TYPE MOLDING MATERIAL

Sales in Pounds



Polystyrene-type molding material by end use



Styrene-type resin sales, 1954-1957[a]

Use	*1954* lb.	*1955* lb.	*1956* lb.	*1957* lb.
Molding materials[b]	309,000,000	386,000,000	402,000,000	400,000,000
Protective coating resins[c] (straight and modified)	80,000,000	94,000,000	93,000,000	95,000,000
Resins for other uses[d]	68,000,000	92,000,000	108,000,000	107,000,000
TOTAL	457,000,000	572,000,000	603,000,000	602,000,000

[a] Source: U. S. Tariff Commission, except 1957, which is estimated.

[b] Includes plasticizers, fillers, and extenders; modified and copolymer molding or extrusion materials; resin for foam made from beads but not that sold in expanded form which is reported in "Resins for other uses."

[c] Includes high styrene-butadiene resin for latex and paper treatment; also resin for styrenated alkyds.

[d] Includes high styrene-butadiene rubber reinforcing resins; ion exchange resins; polystyrene used in floor coverings; metal treating resins and prefabricated polystyrene foam.

NOTE: Totals for "protective coatings" and "resins for other uses" have been intermingled in company reports to Tariff Commission and, therefore, are far from accurate.

an almost-record first quarter of over 105 million pounds.

However, September sales bounced back to a 37 million-lb. volume for the fourth best monthly record in polystyrene history and October may have been better. If December volume can be kept near 30 million lb. the total sales volume for 1957 will be over 400 million lb., but December has always been an exceedingly erratic month for polystyrene sales and if it is good this year of 1957, a great many people will be surprised.

The 1957 total for molding material shown in the table above may even turn out to be conservative if the last-quarter volume goes over 90 million pounds. Third-quarter volume was 102 million pounds. Total for the 2nd quarter was 92.8, one of the lowest quarters for the last three years, so it is to be hoped that the last quarter of 1957 can at least match the second quarter. If it does, 400 million lb. is too low an estimate for 1957. There are several estimators who insist that polystyrene won't go over 270 million lb. in 1957, or at best somewhere between 270 and 280 million. Perhaps their estimates were made earlier in the year when the situation looked bleaker than in October.

One less complicated factor about the 1957

monthly figures is that they contain the monthly sales and production figures of Foster-Grant that were absent in 1956. However, the annual figure for 1956 was adjusted by the Tariff Commission so that Foster-Grant's increment was included.

There are still several companies now producing polystyrene which do not report to the Government. They are Hammond Plastics, Worcester, Mass.; Seamco (a division of Seamless Rubber Co.), Hartford, Conn.; and Solar Chemical Co., Leominster, Mass. Their total polymer production is estimated at somewhere near 12 million lb. annually, but the major portion of it is captive.

The volatile fluctuation in polystyrene's monthly sales of from 37.5 million in March to 24 million lb. in June may have been partly due to a price situation that had been uncertain since a year ago last summer. At that time it became known that the styrene monomer producers had agreed to long-term, large-volume contracts to provide rubber-grade styrene monomer for rubber producers at 12¢/lb. with an escalator clause based on current costs; rubber-grade styrene has always sold at three or four cents less than plastics grade because the latter has to be more refined. At the time of that 1956 announcement the price of styrene for plastics was in the neighborhood of approximately 20¢ a pound.

Nearly everyone figured that if rubber-grade styrene was reduced, plastic grade would also come down. In fact, there was a price reduction in September, 1956, but (*To page* 202)

Vinyl chloride

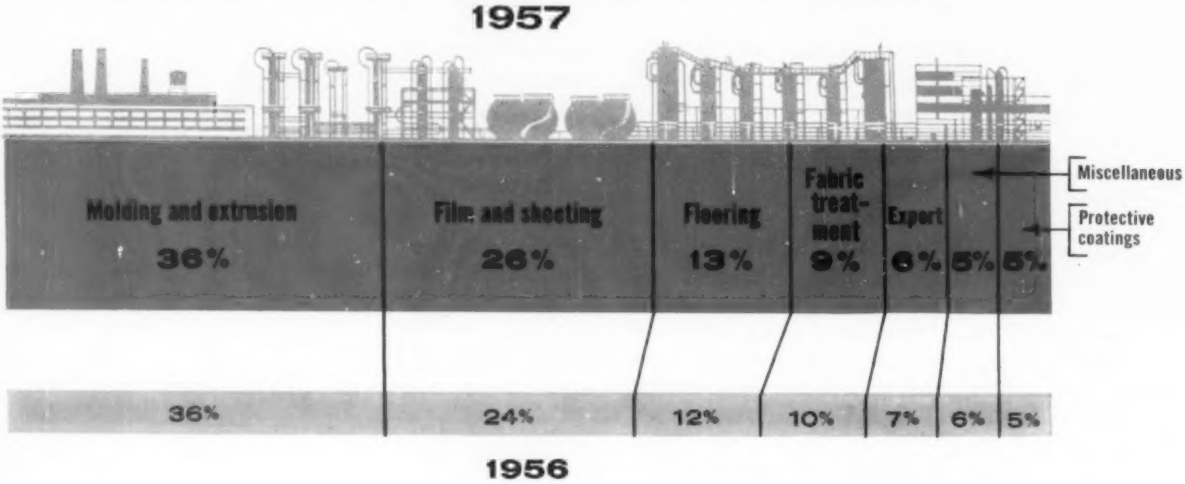
Early in 1957, Modern Plastics quoted a well-known research director as stating that vinyl chloride may not become the first billion pound plastic but that it could well become the first two-billion lb. plastic. This startling statement was based on a belief that improved resins and improved handling techniques would not only increase the amount of material used

Products using plastics in large quantities[a]

Products	*1946*	*1953*	*1956*	*Est. 1957*
Air conditioners (Room units)	28,800	1,044,700	1,828,000	1,600,000
Floor-type vacuum cleaners	2,289,400	2,777,700	3,722,000	3,500,000
Television sets	6,476	7,215,800	7,387,000	6,500,000
Refrigerators (Electric)	2,100,000	3,650,000	3,700,000	3,152,000
Radios	15,955,000	13,369,000	13,982,000	15,300,000
Washing machines	2,020,200	3,460,900	4,440,000	3,800,000
Automobiles	2,148,700	6,116,900	5,816,000	6,300,000
Trucks and buses	940,800	1,206,200	1,100,000	1,100,000
Dwelling units (Non-farm)	671,000	1,200,000	1,118,000	950,000

[a] Factory sales in units

Consumption of polyvinyl chloride and copolymers



Polyvinyl chloride and copolymer consumption 1954-1957[a]

Use	1954 lb.	1955 lb.	1956 lb.	1957[d] lb.
Film under 10 mils	69,000,000	83,000,000	78,000,000	82,000,000
Sheeting 10 mils and over	55,000,000	51,000,000	53,000,000	83,000,000
Fabric treatment[b]	42,000,000	56,000,000	55,000,000	55,000,000
Paper treatment	7,000,000	8,000,000	8,000,000	10,000,000
Floor coverings	34,000,000	56,000,000	66,000,000	82,000,000
Molding and extrusion	148,000,000	183,000,000	205,000,000	240,000,000
Protective coatings	23,000,000	26,000,000	29,000,000	34,000,000
Miscellaneous[c]	34,000,000	58,000,000	74,000,000	61,000,000
TOTAL	412,000,000	521,000,000	568,000,000	647,000,000

[a] First three years are based on U.S. Tariff Commission reports, with estimated alterations necessitated by more varied classifications. Figures for 1957 are pure estimates since Tariff Commission report does not include resin produced by six of the producers who entered the field in 1957. See text, p. 100, for more detailed interpretation.

[b] Laminates for fabric complicate this figure. For the purpose of this report, resin used for laminates is included in film or sheeting since it is produced in that form.

[c] Includes most of the resin for export, in addition to resin for adhesives, ink, foam, and a large quantity for miscellaneous small orders which are not entered as specific end uses. The export figure for 1957 is expected to reach about 40 million lb., including solid resin used in compounds. The import figure will be from 12 to 15 million lb. but is *not* included in above totals.

[d] The film and sheeting figures in this column should be considered together. An accurate estimate for each is impossible because of conditions explained in the text, but the combined total is reasonably accurate.

for existing applications but would also open new fields where vinyl is not now applicable.

The new resins and techniques are being intensively studied but millions of dollars and years of time will be spent before full fruition can be expected. A belief that many of the problems involved will be solved in the next 10 years is no doubt the reason for the optimistic statement about two billion pounds.

One of the principal research objectives is the use of less plasticizer. A small amount of conventional plasticizer can be used to produce resins with as good physical properties as highly plasticized compounds and without danger of plasticizer migration. But the problem is to maintain the flexibility that will make the resin workable. The answer may be in development of equipment built for handling low-plasticized vinyls.

Thin film made of such material may be out

of the question commercially, since there are already so many satisfactory films on the market. It is widely used in Germany, however, where, for example, 90% of magnetic recording tape is unplasticized vinyl. But, as noted many times before, economic, market, and material conditions are almost never comparable in Germany and the United States. On the other hand, there is a definite possibility—even a probability—that thicker sections of unplasticized or low-plasticized vinyl will reach exceedingly large-volume use in the U. S. when researchers hit on the proper techniques of handling.

Thus, rigid vinyls are not expected to grow rapidly until they can be extruded and calendered much faster and better than at present. Wire can now be extrusion-coated with plasticized vinyl at a rate of ⅓ of a mile per minute; if unplasticized vinyl ever even approaches that processing rate, it will be on the way to fabulous heights. A more satisfactory injection molding vinyl compound with good impact and very little plasticizer is also sorely needed. Development of such a material is not beyond the realm of possibility and could add millions of pounds to vinyl's possible markets in many fields of application.

Patience is the watchword; it should be remembered that most present-day vinyl uses required a long period of development: plasticizers, calendering, floor covering, phonograph records—all these required years of experimentation. And now there are plastisols and even rigid plastisols that started from paste or gunk that was used almost like putty in the early 1940's.

The two-billion-lb. prediction is dependent for fulfillment on the skill of the researchers plus an assist from imaginative processors who can find markets for their products. But if the accomplishments of the past can be duplicated in the future the mark is reachable. Whether or not vinyl can beat polyethylene to that goal is, however, a question on which there are many different opinions.

Until the above-mentioned improvements in vinyl chloride begin to take marketable form, future growth may not be sensational, but there are no present signs of a decline or even a leveling off. It is unlikely that there will be another growth of a hundred million lb. in any one year such as there was in 1955, but a growth of about 50 million lb. in 1956 and from 70 to 80 million in 1957 are figures that surpass any other plastic except polyethylene. An in-

PATTERN OF CONSUMPTION OF CALENDERED VINYL FILM[a]

Uses	1953 lb.	1956 lb.	1957 lb.
Draperies, bedspreads, kitchen and bathroom curtains	23,000,000	14,000,000	14,000,000
Yard goods	10,000,000	7,000,000	6,000,000
Adhesive-backed film	—	4,500,000	6,000,000
Closet accessories	6,500,000	7,000,000	6,500,000
Shower curtains	6,000,000	8,500,000	8,800,000
Nursery goods	4,000,000	5,000,000	6,000,000
Baby pants, liners	2,400,000	3,300,000	3,500,000
Table covers	4,000,000	3,500,000	3,000,000
Appliance covers	3,000,000	2,500,000	3,000,000
Furniture covers, indoor and outdoor	3,000,000	3,500,000	2,500,000
Rainwear and sportswear	10,000,000	9,500,000	9,000,000
Aprons, including industrial	1,500,000	3,000,000	2,500,000
Lamination, quilting	—	11,000,000	15,500,000
Wall covering	—	6,000,000	4,500,000
Industrial tape	—	7,000,000	7,000,000
Inflatables	—	4,000,000	6,500,000
Industrial, agricultural, and miscellaneous	20,000,000	14,700,000	17,200,000
TOTAL[b]	93,400,000	114,000,000	121,500,000

[a]This table is intended to include only products made of calendered film up to 10 mils in thickness. Everything 10 mils or over is classified as sheeting. However, it is impossible to eliminate a certain amount of overlapping between film and sheeting and between various classifications of products given above. The figures are given as approximations to show trends. Accurate statistics are not available. See text for discussion.

[b]This does not include film made from imported resin, but it does include that made from resin which is not reported to the Tariff Commission.

crease of 10 to 13% a year for a 600-million-lb. business is healthy if not sensational.

An interesting part of this growth is the continued large size of the export market: over 30 million lb. of resin and 15 million lb. of compound in 1957. A severe drop in exports had been expected because of the increasing production of vinyl chloride abroad, but American vinyl is still in demand in other parts of the world despite dollar problems and availability from other sources.

Imported vinyl chloride may possibly affect U. S. production, but it doesn't seem likely. Imports dropped from around 25 million lb. in 1956 to less than 15 million in 1957, nearly all of it from Italy, but toward the latter part of 1957 some Japanese resin moved in and was being offered at prices of from 20 to 22½¢ delivered. The Japanese have built up a huge resin inventory—partly because of a plasticizer shortage in that country—and were anxious to move it at almost any price, but it is doubtful that such imports will offer a serious threat to American producers for a sustained period of time.

If growth of American-made resin is continued at a rate of 60 million lb. annually for the next three years, the total consumed in 1960 will be 835 million lb., but a loss in exports may finally strike and bring this figure down to 800 million. Authoritative predictions are that growth in 1958 will be only 35 or 40 million lb., which would make it more difficult to reach that 800 million lb. by 1960. And even that isn't as high a figure as was predicted for 1960 by optimists after the sensational growth year of 1955—but it's highly satisfactory progress for any industry. There has never yet been a year when vinyl resin growth hasn't exceeded estimates made in the previous year.

VINYL CHLORIDE FOR MOLDING AND EXTRUSION

Application	1956 lb.	1957 lb.
Phonograph records	32,000,000	35,000,000
Slush and elastomeric molding	40,000,000	48,000,000
Garden hose	8,000,000	7,000,000
Profiles	35,000,000	44,000,000
Wire coating	80,000,000	89,000,000
Rigid pipes and shapes	6,000,000	10,000,000
Miscellaneous	4,000,000	7,000,000
TOTAL	205,000,000	240,000,000

There is some talk that polyethylene and other resins may steal large quantities of the vinyl market and thus deter its growth in film and wire-coating but the chances are that vinyl and polyethylene will both move into markets where each is peculiarly fitted for the application without severe competition from each other. Even if competition from polyethylene becomes severe, it would probably only slow down vinyl's growth rate without creating a drop in volume.

The 70 to 80 million-lb. increase in 1957 will not show in the Tariff Commission's report since six of the companies that started operations in 1957 are not reporting to the Government. These companies, with estimated annual capacity when brought to full production in 1958, are:

Insular Chemical	12,000,000 lb.
Great American	3,000,000 ,,
Pantasote	12,000,000 ,,
Thompson	18,000,000 ,,
Cary	12,000,000 ,,
Presto	12,000,000 ,,

It is estimated that these firms, together with Kaiser—an older West Coast company that also does not report to the Government—will consume or sell somewhere from 40 to 50 million lb. of resin in 1957. Over 75% of this is captive. All of these companies buy monomer, in contrast to the older companies which, except Firestone, produce their own monomer.

In addition to the above, two other new companies started operations in 1957 but their production is included in the government figures. They are Escambia Bay and Borden, with respective estimated capacities of 30 million and 18 million lb. when the latter's expansion is completed.

The bulk of the monomer for most of these plants (except Escambia) is supplied by Allied Chemical from a 40 or 50 million-lb. plant which is scheduled for a 100% expansion in 1958. Ethyl Corp. is reportedly about to build a 50 or 60 million lb. monomer plant. Still an-

other entry is Atlantic Tubing which will have a polymer plant sometime in 1958. Armstrong Cork is operating a pilot plant for producing P.V.C., but so far has made no announcement concerning future plans. In addition, practically all of the older companies have added or are adding new capacity that should be available in 1958. Other possibilities are that U. S. Industrial will enter the vinyl chloride field and that Thompson may expand to a 50 million-lb. operation.

Capacity of the industry at the end of 1956 was somewhere between 700 and 750 million pounds. Only estimates are available and capacity is variable depending upon what type of resin is being manufactured. Capacity at the end of 1958 will be well over 900 million lb.—maybe 950 million. The most optimistic estimates for consumption in 1959 are around 800 million.

The producer who can't afford to wait five or six years for the market to grow, as pointed out earlier in this article, will likely have price and profit trouble during the next few years. One supplier says they will be great years for the processor but mighty rough on the resin producer. Some of the new producers who have already seen the price of monomer creep up to almost 12¢ from less than 11¢ not long ago and who committed themselves to new plants during the 37 and 32¢ resin price periods—in contrast to the present 27¢ price—are already squeezed and are hopeful that a day may soon come when they can sell their surplus resin for a few cents a pound more. However, there is more indication that the *(To page 208)*

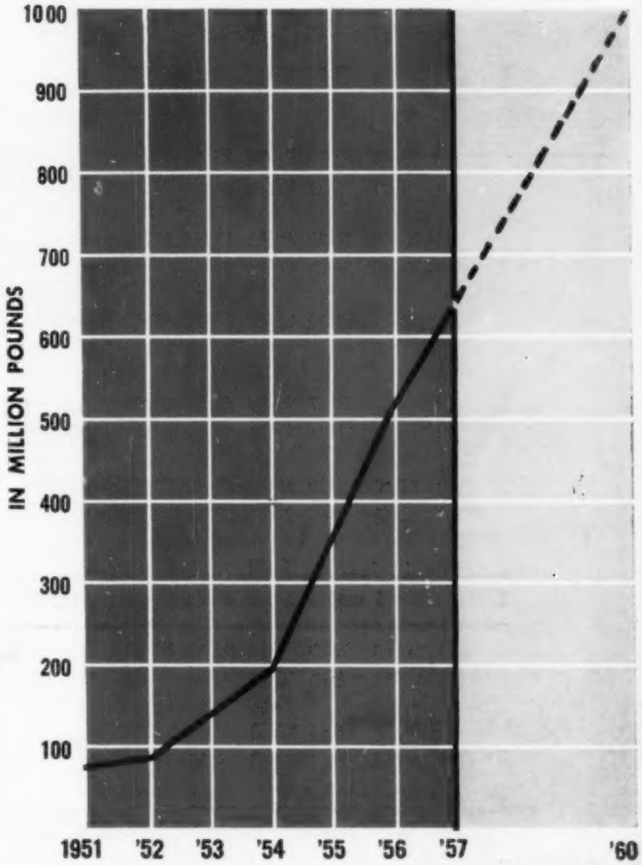
Polyethylene

Guessing games are not just a pastime in the chemical industry—they are actually part of the business. Despite market research and a constantly growing knowledge of how certain properties in a given chemical can best be used to produce a required end product, management is still obliged to do a certain amount of guessing concerning the future of every new product introduced. The results of bad guesses go to the morgue. Executives who make the right guesses frequently become presidents and vice presidents. There's no telling how many presidents, vice presidents, and other top executives are going to develop from the polyethylene guessers but there certainly are scores of candidates.

The guessing today is much more voluble and more diverse than it was when all the new plants were announced a few years ago. The original guessers (a more dignified term is estimators) were correct about the future importance of polyethylene but today's guessers are involved in a much more complex contest of trying to decide how big it will become and when. Opinions differ widely. Even guesses on how today's production is divided between various applications are far from reconcilable. Consequently no claim for pin-point accuracy can be made for the various estimates given in this article. They represent only an attempt to consolidate the estimates of many contributors, no two of whom are in agreement.

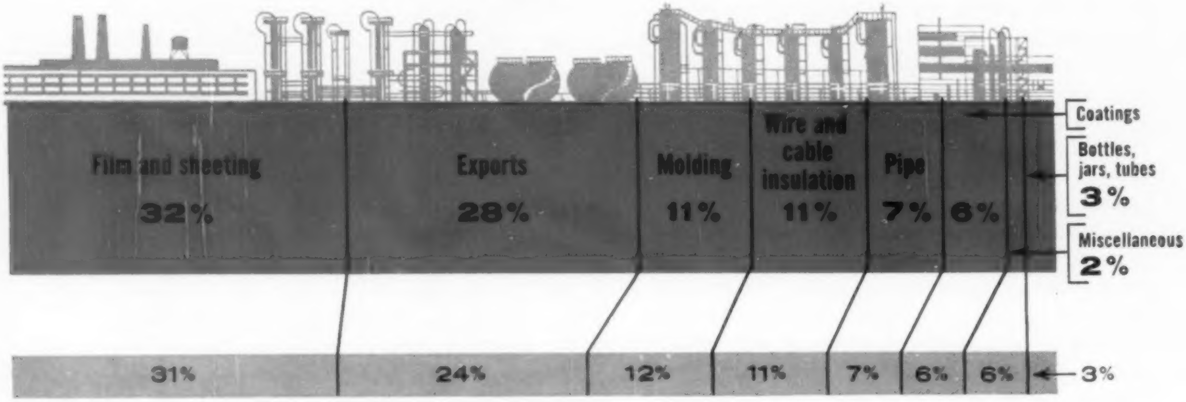
When this article was written late in November it looked as though consumption in 1957

Polyethylene Sales Growth



Estimated polyethylene consumption by end uses

1957



1956

Estimated consumption of polyethylene, by end uses

End use	*1954* lb.	*1955* lb.	*1956* lb.	*1957* lb.
Film and sheeting	70,000,000	120,000,000	160,000,000	205,000,000
Molding	34,000,000	45,000,000	50,000,000	60,000,000
Wire and cable insulation	29,000,000	45,000,000	58,000,000	70,000,000
Pipe[a]	22,000,000	26,000,000	35,000,000	45,000,000
Coatings	20,000,000	30,000,000	30,000,000	35,000,000
Bottles, jars, tubes	7,000,000	9,000,000	15,000,000	18,000,000
Exports	12,000,000	65,000,000	125,000,000	170,000,000
Miscellaneous	13,000,000	10,000,000	41,000,000	27,000,000
TOTAL	207,000,000	350,000,000	514,000,000	630,000,000

[a] This does *not* include reprocessed material which is thought to be used for pipe in about the same portion or perhaps even more than virgin material. However, the figure printed here does include Grade B resin which may be in greater proportion than Grade A.

would be about 115 million lb. over 1956. This is considerably under the volume growth of 160 million lb. in 1956 and 140 million in 1955. Both volume growth and ratio of growth slowed down considerably in 1957. But even if volume growth drops to 120 million lb. a year the industry can still reach that often mentioned one billion lb. figure in 1960.*

A disturbing note in this big volume consumption is the export figure. In 1956 it was over 125 million pounds. The 1957 figure is not yet complete but early estimates indicate it will be at least 160 million lb. and some estimators think it will be as high as 185 million. That high export figure isn't likely to continue for many years. There are now more than 40 polyethylene plants either built or planned in other parts of the world and they are certain to cut into U. S. exports but probably not seriously until at least 1960. In fact, the day may come when foreign polyethylene resin may

* See table, p. 218.

be sold in the U. S. at a lower price than domestic resin.

Another highly important factor in the growth of polyethylene may be the establishment of polypropylene plants in the U. S. Hercules has already announced that a 20 million-lb. plant is on stream; Montecatini of Italy is ready to export polypropylene to the U. S.; Union Carbide is rumored to be about ready and its recent establishment of a Polyolefins Div. would seem to be confirmation; Esso is always mentioned as a possibility when prospective producers are mentioned; Du Pont is known to have applied for patents in this field; Phillips Chemical Div. and Standard of Indiana have both let it be known that polypropylene can be produced by their respective catalyst systems and doubtless their licensees would have that privilege. Many others also have their eye on propylene possibilities.

Polypropylene is definitely competitive with polyethylene, especially in molded items, bottles, and possibly pipe, but the Hercules introductory price of 65¢ a pound as compared with 47¢ for low-pressure-processed polyethylene and 35¢ for the high-pressure variety will probably have to come down before this new material cuts seriously into polyethylene. Of course, polypropylene is lighter in weight than polyethylene and thinner sections can be used but its cost is still high. It is being suggested for many nylon applications and for many of the molded items that are now produced from the 40 to 60¢/lb. plastics. It may be some time before a satisfactory low-priced film is made from polypropylene but producers are confident that it will come. Propylene monofilaments are one of the particular products from which great results are expected.

Availability of polypropylene means far more to the plastics industry than simply the introduction of another plastic. It marks the beginning of commercial production of stereospecific plastics which in turn means that molecules can be produced to a predetermined geometric form. Thus it will be possible to tailor-make plastics to a much greater degree than ever before—and develop properties that are far

COST TABLE: Plastics for molded containers

MATERIAL		Base price[a] per lb.	Specific gravity, molded	Cost per cu. in.	Color range	Molding method[e]
Acrylics	Clear	$0.55	1.18	¢2.36		I
	Colors	0.59	1.18	2.51	Unlimited	
Cellulose acetate	Clear	0.50	1.3	2.35		I
Translucent	Colors	0.46	1.3	2.16	Unlimited	
Opaque	Colors	0.39	1.3	1.83	Good	
Butyrate	Clear	0.62	1.28	2.87		I
	Colors	0.62	1.28	2.87	Good	
Ethyl cellulose	Colors	0.72	1.15	2.99	Good[d]	I
Melamine[b]	Colors	0.45	1.50	2.44	Good[d]	C
Phenolics[b]	Brn. or blk.	0.205	1.36	1.00	Limited	C
Polyethylene	Natural	0.35[c]	0.92	1.16		I
	Colors	0.44[c]	0.92	1.46	Limited	
Polystyrene[b]	Clear	0.275	1.05	1.04		I
	Colors	0.295	1.06	1.13	Unlimited	
Modified styrene	Natural	0.32	1.07	1.23		I
	Colors	0.345	1.07	1.33	Good[d]	
Ureas	Colors	0.33	1.50	1.79	Good[d]	C

[a] The prices given here are those prevailing at the time this table was prepared. Current prices should be obtained for purposes of actual comparison.
[b] General-purpose grade.
[c] Polyethylene resins now available range in density from 0.92 to 0.96, and prices for natural range from 35 to 47¢ a lb.; for colors, from 44 to 53¢ a lb. Cost per cu. in. ranges from 1.16 to 1.56¢ for natural, and in colors from 1.46 to 1.83¢.
[d] In solid colors. [e] I=Injection molded. C=Compression molded.
Courtesy *Modern Packaging* Encyclopedia Issue, 1958

COST TABLE: Papers – Films – Foils[a]

MATERIAL[b]	Cost per lb.	Yield, sq. in./lb.	Cost per 1000 sq. in.
Glassine			
Bleached, 25 lb.[c]	$0.24	17,280	$0.014
Lacquer coated, moisture-proof, heat sealing, 28 lb.[c]	0.45	15,428	0.029
Laminated, bleached, 47 lb.[c]	0.30	9,191	0.033
Waxed paper			
Bread-wrapper grade, 39 lb.	0.22	11,080	0.020
Liner grade, moistureproof, amber, 31 lb.	0.22	13,935	0.016
Cellophane			
Moistureproof, heat sealing (300 MS)	0.62	19,500	0.032
(300 MS 51 or MS-1 type)	0.62	21,000	0.030
Moistureproof, water resistant (300 MSA or MSB)	0.69	19,500	0.035
Polymer-coated (300)	0.79	19,500	0.04
Cellulose acetate			
Cast (1 mil)	0.93	22,000	0.042
Extruded (1 mil)	0.74	22,000	0.034
Polyester film	2.25	20,600	0.109
(½ mil)	2.75	40,000	0.069
Polymer-coated (½-mil base)	2.50	27,500	0.091
Polyethylene (1.5 mil)	0.53	20,000	0.027
Polyethylene-cellophane			
(1 mil poly-300 MS)	1.07	11,800	0.091
Pliofilm (80 FM-1)	1.10	33,000	0.033
Saran (1 mil)	1.04	16,300	0.064
Vinyl Cast (1 mil)	0.87	21,600	0.040
Extruded (1 mil)	0.79	21,500	0.036
Foil-acetate			
(1 mil Al. foil-1 mil acetate)	1.47	6,490	0.230
Foil label stock			
(0.00035 Al. foil-29 lb. paper)	0.47	9,195	0.051
Aluminum foil			
Thickness, inches			
0.00035	0.845	29,200	0.029
0.0005	0.805	20,500	0.039
0.0007	0.76	14,600	0.052
0.001	0.71	10,250	0.069

[a] This comparison of approximate costs is intended only as a guide. The figures given were obtained from 1957 price lists and are based on "volume" orders.
[b] Typical packaging gages, standard commercial grades, unprinted, are given here. The reader must understand there are other commercial grades, thicknesses, and types.
[c] Based on a ream of 500 sheets, 24 by 36 in., or 3000 sq. ft.
Courtesy *Modern Packaging* Encyclopedia Issue, 1958

beyond any of the industry's present conceptions. However, it will probably be several years before polypropylene actually becomes a big-volume plastic. There will be the usual problems of development, marketing, and handling as in any other new material. Producers expect it to grow alongside polyethylene rather than cut into it. From Germany it is reported that polypropylene is expected to affect the molded polystyrene market more than polyethylene but the price differential is not explained.

In the meantime, producers are concentrating their efforts on enlargement of the market for polyethylene. Capacity is growing by the month as companies add to their facilities and new ones go on stream. A little-considered fact is that production (660 or so million lb.) in 1957 was not too far behind capacity, insofar as the high-pressure production is concerned and that less than 15 million pounds of low-pressure processed material was consumed. Many high-pressure plants operated at capacity throughout the year, but two or three were nowhere near their announced capacity. Others are still adding facilities. It is likely that total capacity at the end of 1957 was not much over 700 million pounds.

But capacity of high-pressure producers in 1959 may be something like this:

	Million lb.
Union Carbide	370
Du Pont	200
U. S. I.	170
Dow Chemical	100
Spencer Chemical	95
Monsanto	60
Texas Eastman	55
Koppers	25
Total	1075*

*Allied's low-molecular weight material not included.

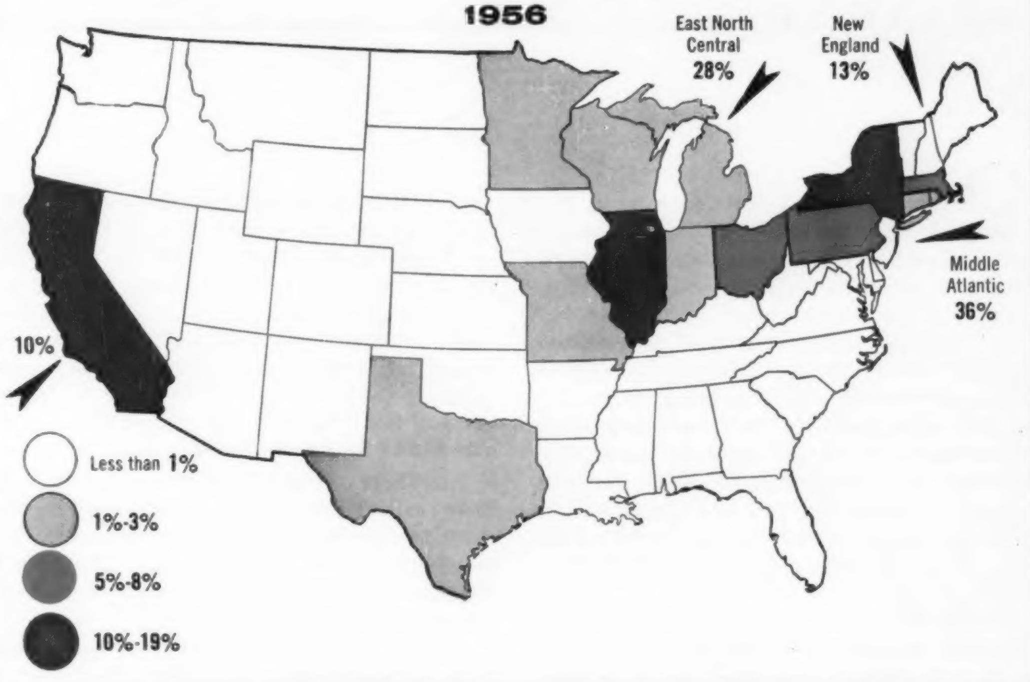
So the high-pressure producers hope to find ways and means of selling from 200 to 300 million lb. more in 1960 than in 1957. That's not impossible but will require a lot of selling.

The rub is that the low-pressure operators also expect to sell from 200 to 300 million lb. in 1960. But chances are that sales of high- and low-pressure polyethylene together won't go over a billion lb. in 1960, so apparently there is going to be a struggle between the two for that 300 or 400 million lb. needed before the billion lb. mark is reached.

The capacity of the low-pressure producers in 1959 or '60 may look like the table on p. 216. The figures are of course only guesses in nearly

Location of custom plastics molding industry

1956



every case because there is still time for additions or deletions before 1959 or '60 but they give an idea of quantities that are being discussed in the industry. Today only five of the listed companies have announced commercial production—Phillips, Celanese, Hercules, Grace, and Allied—the latter on a limited scale of pipe resin only but just (*To page* 216)

Nylon

Not many new applications for nylon-6/6 were announced in 1957 but there was a noticeable increase in poundage used by already established applications. It is believed to have grown at a rate comparable to the growth pattern of 1955, which was the greatest of any year. There are now about 600 molders who mold nylon upon occasion but about 80 of them do more than 80% of the total business. The 1957 rate of growth was considerably more than 1956 when a decline in the automotive and appliance industries cut into two of the larger volume uses for nylon. Du Pont has never released figures on sales volume of nylon but their competitors guess that poundage for the industry in 1957 was in the neighborhood of 30 million pounds.

Capacity for nylon is continuing to increase, with the new Du Pont facilities now more than 80% completed.

Allied, which entered the field two years ago with production of nylon-6 made from caprolactam monomer (which the company also produces) has made no particular claims as yet concerning progress. Two new producers—Spencer Chemical and Foster-Grant—entered the field with new plants in 1957, but both admit that their plants, which produce nylon-6, are small-volume operations that will be enlarged later when volume builds up. The Spencer plant is producing a material similar to Akulon made by AKU in Holland and Foster-Grant's product is similar to Grilon which is produced in Switzerland.

The new producers assert that (*To page* 225)

Significant trends

On the strength of their showing in 1957, plastics applications look as if they are standing on the threshold of what can conceivably be the greatest year in history. It is not a matter of the *number* of new applications appearing in 1957 that prompts enthusiasm, but rather their *quality* and the *type* of blue-chip markets at which they are aiming. If anything, the number of *new* applications in 1957 was surprisingly small, but when plastics can move successfully into such booming billion dollar businesses as aircraft, building, missiles, and agriculture, as was the case in 1957, then the industry can justifiably look with great expectations to the years ahead.

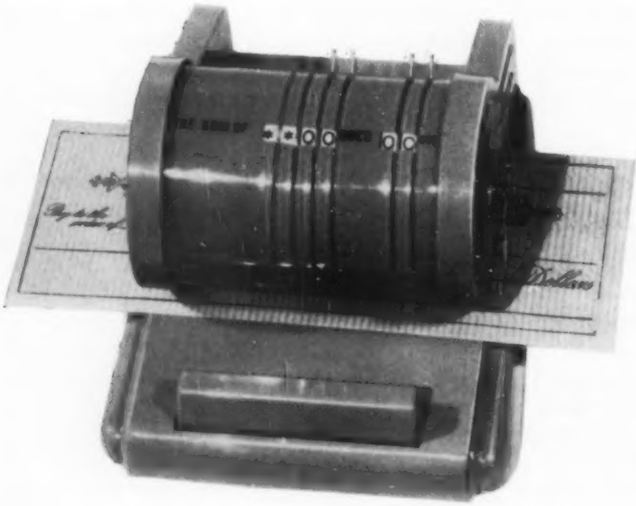
Volume-wise, of course, many of these new applications are still relatively small, particularly in the light of the healthy year which toys, housewares, appliances, and similar existing large-volume markets for plastics enjoyed. Here again though there was little in these fields that could be described as "new" or "different." Instead, it was a case of existing applications being bigger, more imaginatively designed, more soundly engineered, and better merchandised. But it still added up to more business for plastics.

Questions to be answered

Building on this bedrock, the application picture seems likely to be in for a drastic change in 1958. Some experts feel that producers are holding off on new applications until they can be sure just where the recently introduced plastics materials will fit.

Will the polyolefins with their increased stiffness and higher heat resistance affect the toy and houseware picture? What about the poly-

It was not so much the new applications that attracted attention in 1957 . . .



Molded high-impact styrene and sheet acetate are used in housing and operating parts of all-plastics check printer. Application represents new use of plastics in office equipment field. (Photo, Catalin Corp. of America)

in plastics applications

Developments of 1957 forecast
an even brighter future for the industry

acetal resins for aerosol bottles, gears, tumblers, telephones, bearings, cutlery handles, housewares, and automotive parts (Jan.,[1] p. 258)? Will polymethylstyrene find an outlet in radio cabinets, battery cases, or housewares (March, p. 298)? And what will happen with some of the new cellulosics, the new nylons, the new acrylics, the new styrenes? And will the polycarbonates become a commercial reality for coil forms, structural components, automotive parts, housings, bottles, handles, and battery cases (May, p. 41)?

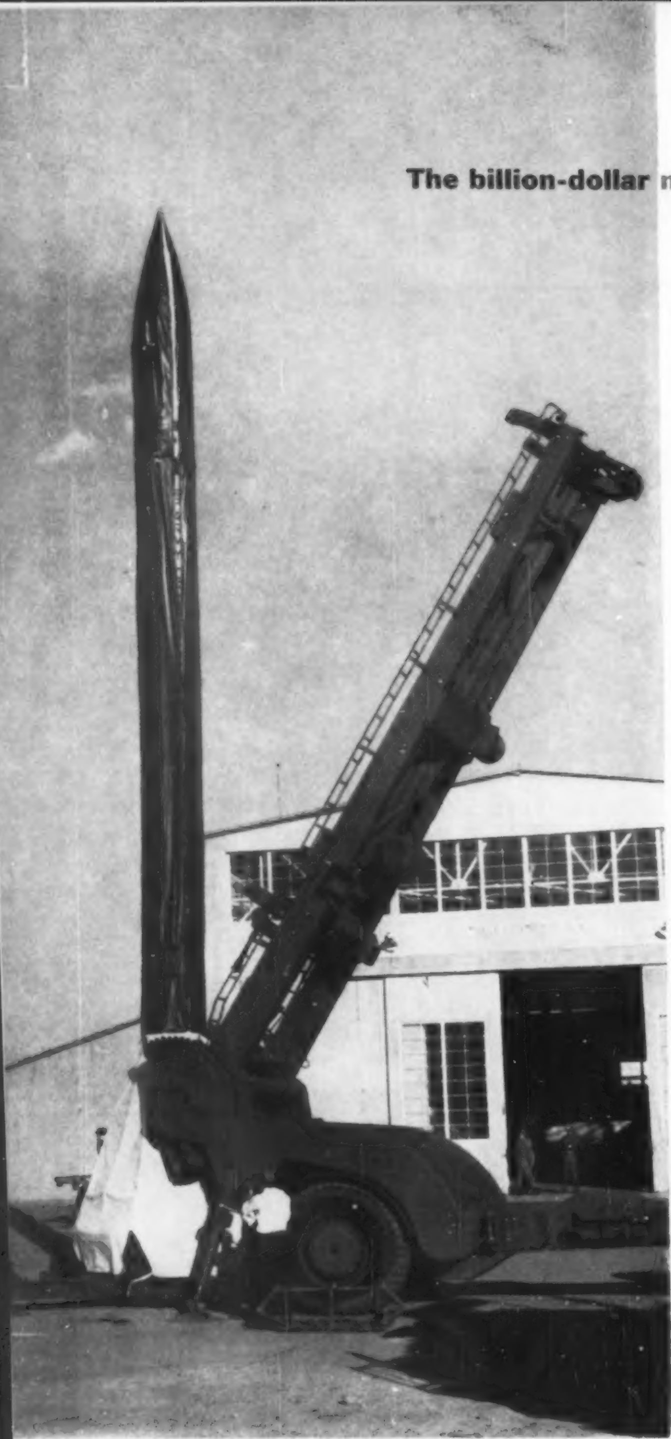
In the same way, manufacturers are keeping a wary eye cocked on the fast-breaking processing developments that can conceivably affect applications they are contemplating. As just one example, sheet forming techniques today are a far cry from those used only five years ago to turn out small toys and novelties. In 1957, machines were introduced that were large enough to produce pieces of TV studio scenery measuring 12 ft. long by 6 ft. wide (April, p. 100) or entire linings for trailer trucks measuring 52 by 104 in. (May, p. 107). And watch out for large outdoor billboards formed entirely from plastics sheet. They're on the way! Extrusion techniques similarly made

[1] All references are to 1957 issues of MODERN PLASTICS.

. . . as the types of blue-chip markets into which they were going

Lucrative furniture field has just barely started to become a promising market for the all-plastics drawer. Strides made by styrene (shown), phenolic, and reinforced plastics drawers in 1957 only hint at the tremendous potential in store. (Photo, Prolon Div., Pro-phy-lac-tic Brush Co.)

The billion-dollar missile and aircraft field stood out...



Plastics applications for missiles ranged from structural elements to the protective weather cover of vinyl-coated nylon shown above. (Photo, Jet Propulsion Lab.)

important advances during 1957 (Nov., p. 99). Three or more sizes of pipe can now be extruded from a single die. Wallboard of styrene alloy, surfaced by post-extrusion lamination, is being made in quantity today. And two, three, or four extruders operating together through a single die are used to produce film 40 ft. wide or more for construction and agricultural use.

Automation, of course, made its mark in 1957 on virtually every type of processing technique. Of particular note was a set-up for combining automatic compression presses with automatic feeding and high-frequency preheating of phenolic (without preforming) to attain a remarkably high degree of automation in the molding of automotive components (Oct., p. 120).

Broader bases needed

But whether it is the rapid developments in materials or in processing that have held manufacturers back in 1957, it seems almost certain that 1958 will see many questions on materials and processes answered and research activities advanced enough to resolve many of the issues in manufacturer's minds. Secondly, and most important, plastics resins of all types will be in plentiful supply in 1958—and bases of application will almost *have* to be broadened if outlets are to be provided.

The situation is almost parallel to that which existed in the early months of 1953 when the increase in resin supply prompted MODERN PLASTICS to advise: "We need new thinking about new markets in addition to planning for the expansion of those already opened."

Today, the challenge is much the same. This report, while pointing up what is being done by the plastics industry to meet it, cannot by any means cover the sum total of activities in plastics applications in 1957. Rather, it is concentrated on some of the new directions these applications have taken.

Missiles and supersonic aircraft

By all standards, the year 1957 was the year of the missile. The concept of missile flight and space travel captured the imagination of the American public.

For plastics, this emphasis was a healthy one. In the same way that earlier wartime activities were responsible for giving to the consumer and industrial fields such materials as polyethylene and the isocyanate foams, so too is

missile research expected to develop materials and techniques that can conceivably be adapted to civilian applications. The work being done in the missile field with high-heat-resistant plastics has already excited considerable attention. There are heat-resistant plastics in use today that can withstand temperatures up to 600° F. and momentarily expected are some that can take heats in excess of 1000° F. (March, p. 125). There are new structural concepts inherent in missile components strong enough to withstand the buffets of a return trip to earth from outer space. New approaches to composite structures and sandwich materials have also emerged from the missiles field and have already affected the building industry (July, p. 94). Similarly, the electronics industry has learned some important lessons from missile designers on the use of plastics in printed circuitry, potting, and miniaturization. And it's an odds-on bet that somewhere some manufacturer is studying the commercial implications inherent in the use of foamed plastics in protective wing-tip pods for guided missiles (June, p. 116), not to mention a protective weathercover for a 45-ft. long missile fabricated of vinyl-coated nylon held together by a unique zipper system (Nov., p. 116).

The airplane industry, long a healthy market for plastics, is also beginning to show signs of expansion in some interesting directions. For one, thanks to new techniques now available, plastics components for aircraft are bigger and more soundly engineered than ever before. What was probably the largest single airborne part ever fabricated of reinforced plastics—a radome 30 ft. in diameter and several feet thick at its center—appeared in 1957. Compound the size of this object with the fact that it was conceived, designed, tooled, molded, finished, and installed in 120 days and it can be seen why the industry is so excited about plastics potential (Feb., p. 104). And as in the missile field, the experiments currently being done on structural, high-heat-resistant plastics components for aircraft will probably have important repercussions in other fields. Phenolic-bonded asbestos or fibrous glass cloth already hold the answers to many of the structural needs of supersonic aircraft (Feb., p. 83).

A strange new world

With the eyes of the world turning toward outer space, strange new shapes are filling the skies and strange new silhouettes are dotting the blue. Plastics film, both polyethylene and polyester, are being used for the host of balloons now going aloft carrying scientific instruments for studying weather conditions (June, p. 111). And when a balloon was recently used to carry a missile many miles into space before firing, a plastic film balloon did the job.

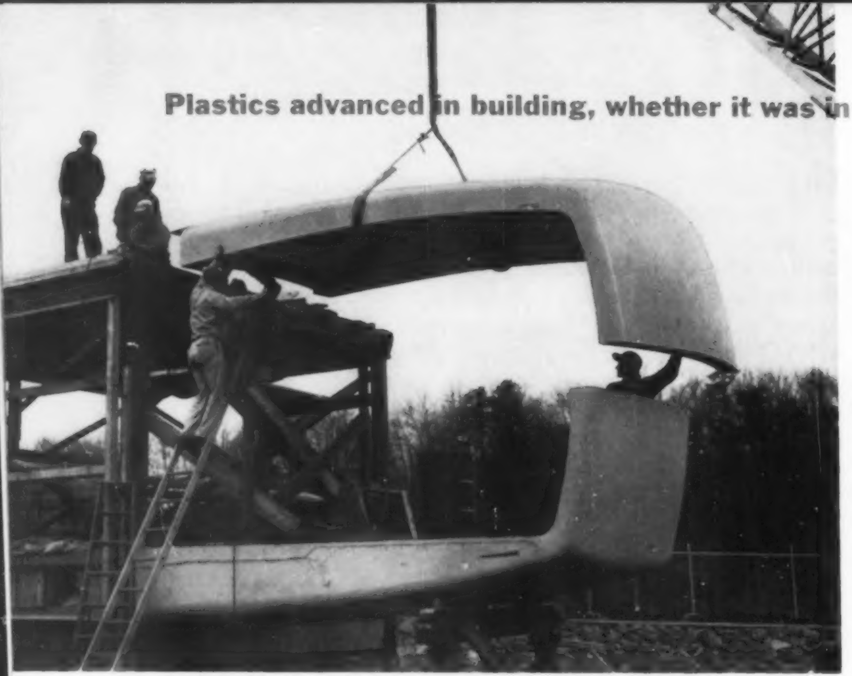
On the ground, the various devices designed to scan the skies and study the strange happenings have proved a lucrative market for plastics. One portable radar set uses an antenna based on vinyl-coated fibrous glass fabric and a metallized polyester film (Aug., p. 98).

Powering this "world of tomorrow" also

...together with all the other accessories for "space travel"

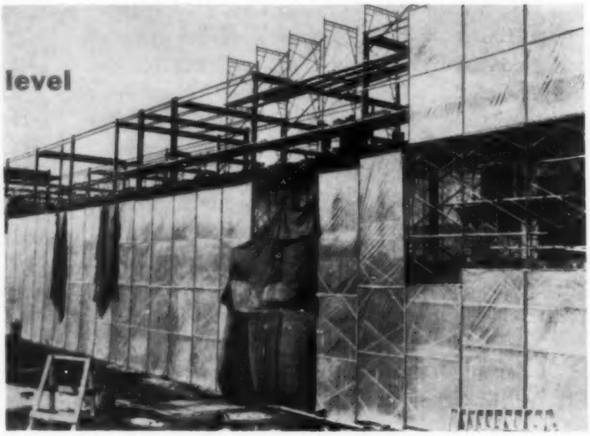
Radio telescope for studying universe through r.-f. signals emitted by celestial bodies makes use of reinforced plastics parts as structural members for multiple-feed system—at upper left. (Photo, Celanese Corp.)

Plastics advanced in building, whether it was in "blue sky" thinking...



All-plastics "House of the Future" dramatized plastics potential in building. Prototype model, shown here in early stage of construction, uses plastics sandwich material for structural members. (Photo, Monsanto Chemical Co.)

...or on a more practical immediate level



Work on building can proceed uninterrupted even in inclement weather when structure is covered with polyethylene film construction shield. This application has grown into large-volume market for polyethylene film. (Photo, Olin Mathieson Chemical Corp.)

seems to be a job cut out for plastics materials. Electronics, which hold the key to so many of these new developments, depend to a large extent on plastics printed circuitry and cast plastics resins for potting and encapsulation. If, as rumor has it, molded plastics printed circuit bases in tube form or other shapes become available in the near future, the potential market for plastics in this field will be multiplied many times over. New convenience in packaging systems for plastics potting resins should also help in the growth picture. Typical of the activity in this direction is a recently introduced two-compartment, single-use flexible polyester film package for holding an epoxy casting resin and its activator. When using the resin, the barrier between the resin and its activator is broken and the two components are mixed together and poured into an expendable plastic mold (Feb., p. 90).

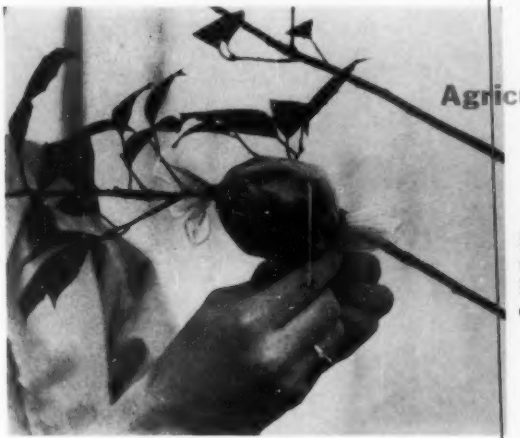
Booming building business

As in the field of missiles and supersonic aircraft, the future for plastics in building is tied in with the growth of completely new concepts. With an estimated 1⅓ million homes going up in 1957 and with building materials costs on an ever-increasing upward spiral, interest has cen-

tered on the use of plastics for unique prefabrication building methods that spell out lower housing costs. The new terminology for that segment of the plastics industry interested in the building field already encompasses such previously unfamiliar terms as the composite structure, the bent, the hyperbolic paraboloid, and the tension structure (April, p. 5). Fortunately, there is already a healthy bedrock for this phase of plastics activity in the research which is done with the various structural elements that are used in aircraft, railroad, and refrigeration applications.

The most dramatic promotion of plastics building applications in 1957 was in the all-plastics "House of the Future" which incorporates such structural elements as plastics roofs, walls, partitions, and even a molded one-piece bathroom (June, p. 143). And for the Brussels 1958 exhibition, the United States planned a building with the entire roof fabricated of plastics sandwich materials (April, p. 198).

On a more work-a-day level, a number of buildings intended for actual year-round use began to appear with plastics structural elements as an integral part. One such building, intended for use as a research center, included reinforced polyester panels (with and without honeycomb or polystyrene foam sandwich construction), foamed styrene panels for part of the roof, acrylic windows and louvers, and polyester-faced concrete (June, p. 124). Phenolic honeycomb structures showed up in a number of buildings as primary structural elements for ceilings, floors, doors, etc., and panels made up of reinforced plastics sheet bonded to an aluminum grid found use as a translucent curtain wall panel. Even the concept of a collapsible building fabricated of vinyl-coated nylon and held up entirely by low-pressure air—an



Agricultural applications continued to fulfill their potential...

Specially formulated polyethylene film is used as a wrapping material for grafting, budding, and air-layering. (Photo, Jet Specialty Sales Co.)

...but the grower of plants and flowers found a new competition in plastics

Cast vinyl plastisol plants—life-like in appearance and texture—can be produced in almost limitless variety of shapes and colorations. (Photo, B. F. Goodrich Chemical Co.)

Consumer goods profited by higher quality, more imaginative design...

Intricate molding of polyethylene shopping bag typifies new successes being scored by plastics housewares through ingenious design and sound engineering. (Photo, BW Molded Plastics)

idea that was still in the "blue sky" stage in 1956—turned up in 1957 as a practical answer to warehousing problems (Jan., p. 116). Rigid plastics foam as structural insulation also seemed a certainty to enter the building field in volume within the next few years (Oct., p. 124).

The more conventional markets for plastics in the building field continued a steady climb upward in 1957. Lighting applications, thanks to the development of new light-stable materials, and glazing applications had an especially good year. In the latter area, several new materials made an appearance including an acrylic-modified polyester for reinforced plastics panels that was claimed to improve visibility and resistance to discoloration by ultraviolet light (June, p. 269). In the plastic tile field, several new designs appeared, including two mosaic-type tiles—one vacuum formed from a preprinted sheet of vinyl (May, p. 107) and the other made up of individual injection molded styrene tiles mounted on a treated gauze fabric (July, p. 112).

Consumption of polyethylene film as a moisture vapor barrier in home building construction, as a form lining in concrete work, and as a protective covering for buildings under construction climbed sharply (May, p. 117). One of 1957's dramatic successes along this line was the use of polyethylene film to permit the installation of a 72- by 24-ft. concrete roof without the need for conventional and expensive forms to hold the concrete (March, p. 252). For applications of this type, the market for polyethylene film is confidently expected to reach an ultimate volume that will be in excess of 100 million lb. annually.

Agricultural markets

Not to be outdone by the building market, the agricultural field also increased its consumption of plastics materials. Again, as with building, it was the factor of higher individual

...the concept of disposability...

Low-cost disposables, including such items as thin-wall styrene coffee cups, have secured a good foothold in the field long dominated by their chief competitor—paper. (Photo, Monsanto Chemical Co.)

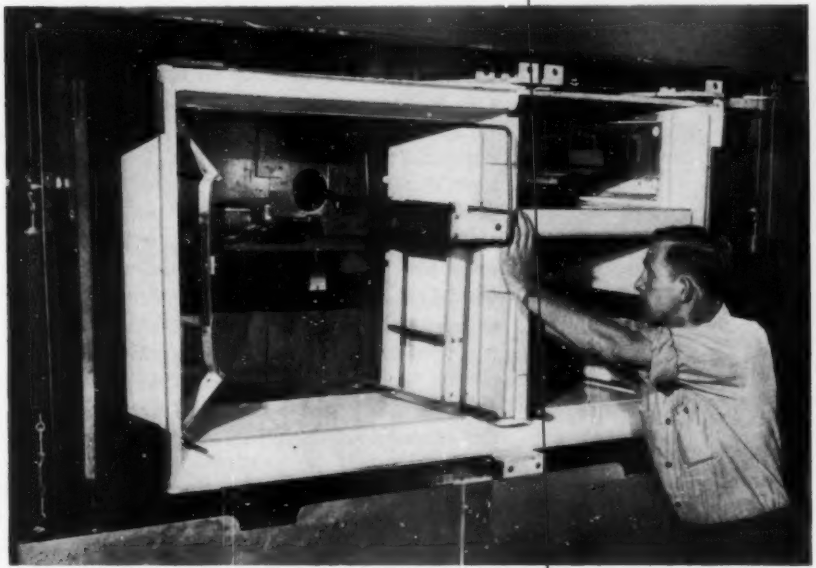
investment (it has risen in 15 years from $3500 per worker per farm to $15,000 per worker per farm) that prompted the farmers to turn to plastics as a means of increasing production, conserving moisture and soil, lowering labor content of crops, and bringing about significantly lower costs (July, p. 89). It was primarily film and sheeting that discovered the agricultural field as an important outlet. One report had it that farm markets for vinyl film and sheeting alone will eventually amount to 50% of the total 1955 sales of vinyl film and sheeting in this country and that the projected figure for plastics film (conceivably including both polyethylene and vinyl) in this country would be in the neighborhood of 100 million lb. by the year 1965.

These agricultural applications for film and sheeting took several forms. One was as a construction material for greenhouses. While polyethylene film and glass-reinforced polyester sheet took a good share of this market, several of the newer materials showed promise of a bright future, including a new extruded oriented styrene-acrylonitrile copolymer sheet that permits increased ultra-violet transmission and transmits almost 100% of the sun's infrared rays while holding back "earth radiation" in the 40 to 100° F. range.

Silos and silo covers represent another big agricultural market for vinyl and polyethylene films. And plastics film mulches and row covers that increase the yields of plantings have already created a revolution in farming techniques. A film mulch was made available even for the backyard gardener (May, p. 126). This mulch consists of a specialized black, 1½-mil polyethylene film, 27 in. wide and printed with grid markings that enable the gardener to plant seeds, seedlings, etc., at uniform distances from each other. Vinyl liners for irrigation ditches and ponds also began to take on the appearance of a major market for plastics materials (Feb., p. 236).

Paradoxically, while plastics were doing so much for the farmer in 1957, at the same time they certainly weren't making life any easier for growers of ornamental plants and flowers. Life-like plant leaves vacuum formed from silk-screened polyethylene sheet and plants

...and there were some important lessons to teach

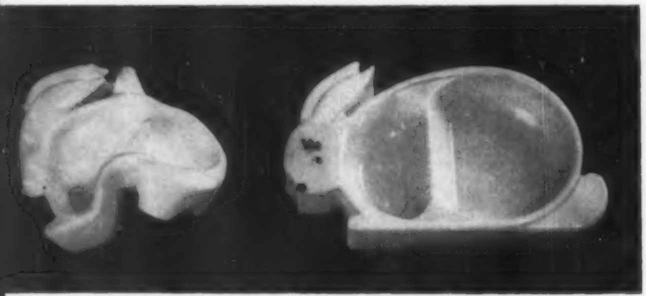


Sandwich construction—foamed styrene core and styrene sheet faces—used in all-plastics refrigerator aroused interest of building and aircraft fields. (Photo, Westinghouse)

At the same time, existing markets strengthened their position...

All-plastics or plastics-coated automobile seat covers did a record business in 1957. Among models introduced during the year was vinyl snap-on version. (Photo, Firestone)

...manufacturers revised future plans to include new materials...



Polymethylstyrene baby dish (right) with heat distortion temperature of 215° F. was boiled for 30 min., remained unaffected. Styrene dish (left), boiled for the same length of time, distorted badly. (Photo, American Cyanamid Co.)

molded of vinyl plastisol began to appear in volume in homes and public places (Sept., p. 133). By year's end, an influx from overseas of realistic flowers—roses, daisies, etc.—molded of polyethylene and vinyl indicated the start of what can be a really fabulous market for plastics in artificial yet amazingly real-looking foliage and flowers.

Consumer goods

Several areas in the consumer goods field moved quietly in 1957 to record highs in consumption of plastics. Again, there were no really "new" applications that accounted for the advance. Instead, it was the cumulative effect of many years of designing these products better, engineering them more soundly, and selling them to the public. But hovering in the background of each of these highly competitive fields loomed the shadow of the new materials. No one seemed to know what producers were doing with them—but everyone seems to be experimenting with them and everyone seemed to feel that their appearance would blow the lid off what are already counted as some pretty healthy markets. A review of just four of the top markets for consumer goods —toys, hous wares, appliances, and furniture— can exemplify just what is happening to plastics throughout these lucrative consumer markets.

Toys by the thousands

Several factors—an increase in child population, an increase in disposable income, and an emphasis on buying better quality and higher priced toys—were responsible for the estimated record of \$1¼ billion retail sales in toys in 1957 and for the corresponding record growth in the utilization of various plastics materials in the manufacturing of toys.

In a market research report on toys published at year's end by a leading manufacturer, several interesting comments on plastics toys were noted: "toy producers are going into higher priced plastics as an answer to foreign competition . . . tough polyethylene large toys, because of their safety and durability, are winning excellent consumer acceptance . . . plastics are now used in more toys than all other types of material . . . vinyl inflatables had a record year . . . and dolls, which still stand out as a major market for plastics, also had a record year." In the latter category, many manufacturers suddenly discovered the vinyl plastisols not only for doll parts but for rigid hobby

horses, for rotationally molded hollow balls, and for hundreds of other toys and novelties (Dec., p. 103).

With such a record year under the belt of the plastics toy manufacturer, can one imagine what will happen when some of the newer plastics, particularly the tougher, heat-resistant materials, become available in quantity? Already, for example, polymethylstyrene, introduced commercially only a few months ago, is establishing a firm foothold in the field of babies' toys and feeding utensils where its high heat-distortion point (215° F.) makes it ideal for boil-sterilization without distortion or cracking (Nov., p. 119). Many of the flexible foam materials have yet to reach the potential they obviously have in this market (Sept., p. 115).

The housewares market

Plastics, it is estimated by one major producer, already account for 10% of the whole housewares industry. If the activities of 1957 are any indication, the percentage will soon be considerably larger—very soon.

For plastics housewares applications, the year 1957 showed up a strange paradox. On one hand, manufacturers were concentrating their efforts on producing tough, quality products that could boast long life. On the other hand, another group of manufacturers was concentrating on what was, for plastics, an entirely new and revolutionary concept—the theory of disposables and expendables (April, p. 93).

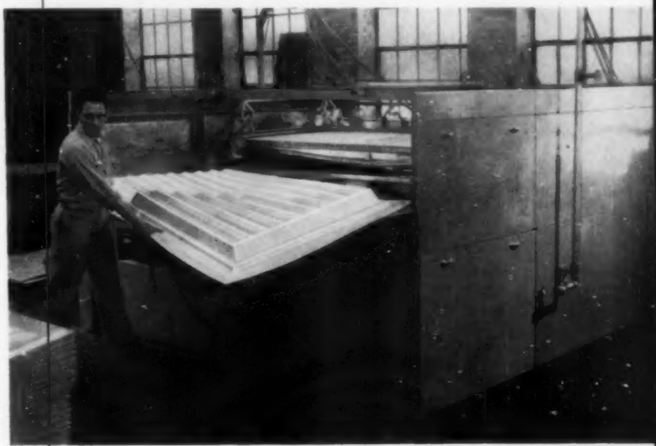
Products that are intended for one-time use: cups, tablecloths, picnic plates, utensils—the whole area so long dominated by paper—began to feel the impact of plastics materials. New processing techniques deserve most of the credit—automatic high-speed molding machines that can turn out thin-wall units at high speeds and automatic extrusion-vacuum forming hookups that can form units at the rate of tens of thousands per hour (May, p. 107). Thanks to one technique developed for pressure embossing and inlay printing on polyethylene film in rates at excess of 50 yd./min., low-cost polyethylene film tablecloths, which are sufficiently low-priced to be disposable, suddenly developed as competition to paper napkins and tablecloths (Jan., p. 124).

In the more conventional housewares applications, plastics had a good year in 1957. Molded polyethylene uses ranging from mixing cups to full-size garbage cans, clear styrene tumblers, acrylic housings for bath scales and clocks, vinyl wall coverings, vinyl-coated papers, and vinyl tablecloths and shower curtains showed up in abundance at the 1957 National Housewares Show (Oct., p. 110). Melamine dishware, particularly decorated, had one of its best years and producers were concentrating on the implications inherent in a decorated melamine handle for draught beer that appeared in 1957—the first practical application (*To page* 227)

...new methods of decorations...

Molding decorated paper foil into melamine beer tap handle represented first use of technique on shapes having compound curvatures. (Photo, Chicago Molded Products Corp.)

...and refinements in processing techniques



Increase in size of thermoforming machines in 1957 made it possible to form trailer truck linings and other parts up to 52 by 104 in. in size. (Photo, Strick)

Plastics Engineering

Dr. James F. Carley, Engineering Editor

1957 Highlights

Concise summaries of the important published contributions to plastics engineering in the past year

The year 1957 was a big one for plastics engineering, as the volume of this review demonstrates. This reviewer feels, however, that with some exceptions, the findings published in 1957 were less fundamental and more limited in scope than those reviewed in 1956. There have been many advances in techniques and methods, and much information on the effects of processing and fabricating conditions on product qualities has appeared, but theoretical contributions have been few. Even the already available body of theory has not been used to good advantage. This kind of research is like sending 100 men out in different directions to find a buried treasure that one man might easily locate if he would only learn to read the map.

We suffer also from duplication of effort, which is particularly evident among the increasing group of linear polyethylene makers. That it is not confined to them alone can be seen from the abstracts of the coming SPE conference papers (p. 144), which were pre-selected for variety.

It takes perhaps 100 to 1000 carefully chosen (and costly) test runs to define a 10-factor system clearly enough so that all the interrelationships are understood and believed in; a few equations can do it better. Engineers in other fields are advancing technically because they have and make use of powerful theoretical tools and are constantly working toward finding new ones. Plastics engineers must do the same.

Articles dealing exclusively with laboratory testing of plastics, test method development, general heat transfer, high-polymer chemistry, rubber processing, and many rheological studies, are not included. Most of these topics are covered in the Technical Section review (p. 153).

A problem faced by the more isolated and busy plastics engineers is where to find books on various phases of plastics engineering. In **"Books on plastics engineering,"** ***J. J. Chapman*** (*SPE J. 13,* 63, Oct. 1957) has compiled lists of technical books available from various U. S. and British publishers on plastics and plastics processing, fabrication and finishing, and mold engineering. The list is not complete, but " . . . can be considered a starting point for any organization desiring to assemble a collection of books on plastics engineering."

Mold making

"Cast mold cavities," by ***Irwin Lubalin,*** Modern Plastics 35, 147 (Oct. 1957).

Using a unique refractory mixture that passes through a rubbery stage before it is cured and does not expand when heated, the Shaw process is capable of making dense, solid castings of almost any intricacy from virtually all castable alloys. The process requires relatively low investment, cuts material costs and inventories, and can easily yield a finished mold in a day. It is likely to be more expensive than hobbing where more than two identical (hobbable) cavities are wanted, and does not compete with machining when the cavity is simple and easily machined. Dimensions may be held to ±3 mils/in. on castings in the 30-lb. range; surface finish is about 70 microinches.

Much the same information, with perhaps more emphasis on casting technicalities and less on economics, appeared in *The Plastics Inst. Trans. and J., 25,* 124 (April 1957) in the article, **"'Truprocess' castings for plastics dies,"** by ***A. Torry.***

"Surface hardening of plastics compression and injection molds," by ***W. Haufe,*** *Plastverarbeiter 8, 2* (Jan. 1957). In German.

Three groups of steels are used in the manufacture of injection and compression molds for plastics molding: steels of natural hardness, which are used as delivered; oil- or air-hardened steels; and steels that may be

surface-hardened. Requirements for a good mold steel are complex, but, of the three steel groups, surface-hardenable steels most nearly meet those requirements. During the hardening and nitriding of molds, mistakes that may lead to rejection sometimes occur. For this reason, following the presentation of basic information, sources of such errors are pointed out.

"Treatment of mold design problems," by ***G. Thayer,*** *SPE J. 13,* 48 (Oct. 1957).

Advice on design of molds for injection molding in general and, with diagrams, solutions of several long-standing problems in mold design. Performance demands on molds are tougher than ever, so "the mold designer needs to let the behavior of the plastic and the end use requirements be factors as strong (in mold design) as the mold fabrication problems."

"Engineering of molds using electroformed cavities," by ***W. J. B. Stokes, III,*** *SPE J. 13,* 29 (March 1957).

The peculiarities, advantages, and special problems are discussed of forming mold cavities by electroplating a nickel shell on a cavity pattern. This nickel shell can be backed up with "hard" copper to give a mold of good heat conductance. Cavities impossible to hob and difficult to machine, cavities with substantial undercuts (whatever the material to be molded will permit), and cavities with finished surfaces as formed can all be made by electroforming. Diagrams show how cavities are mounted and retained in the mold.

"Importance of mold rigidity in injection molding," by ***R. N. Farris,*** and ***P. J. Meeks,*** *Plastics Tech. 3,* 371 (May 1957).

"Almost every factor that can cause the molded part to be different in size or shape from the design can be considered to be a factor in the rigidity of the mold. Individually located cores and cavities are much more satisfactory than those located by guide pins in multiple-cavity molds. A very good method of individual location is the use of tapered surfaces or wedge blocks. Warpage and dimensional changes of the mold should be minimized by thorough heat treating procedures." Where greatest rigidity is desired, steel is preferable to any other available mold material. "Supporting and back-up components should be hardened sufficiently to prevent misalignment by peening or coining of surfaces."

"Spark machining in the die-making industry," by ***A. D. P. Tallents,*** *Plas. Inst. Trans. and J. 25,* 217 (July 1957).

Spark machining is the controlled removal of metal by bombarding the surface to be shaped with electric sparks. A brass negative of the cavity surface is first made, then, using the two pieces as electrodes with a short dielectric-filled gap between them, intermittent sparks of high current density are made to jump across from the brass to the metal to be machined. The hardest materials can be machined in this fashion with great fidelity of reproduction of the brass surface. The method is ideal for making extrusion dies for thin complex sections, for example, and the working surfaces can even be polished by the same means. Electrodes for complex surfaces can be made by assembling simpler components. Tool wear can be precisely calculated in advance, and, since tools are not stressed, they need very little strength. Largest area so far machined was 17 by 5 in., but larger ones can be handled by compositing. Spark is powered by 120-v. d.c., using simple resistor/condenser circuit to get sparking.

"Plastic compounds make molds for vacuum forming," by ***G. T. Morse*** and ***M. S. Schwartz,*** *Plastics Tech. 3,* 547 (July 1957).

Metal-filled epoxy casting compounds are compared with competing materials in the manufacture of molds for forming, and they look good. Making the epoxy mold from a model of the object to be formed is traced through three simple stages: making a plaster master from the model, pouring and curing a flexible negative of this master, and pouring and curing the epoxy mold. Complex molds can be produced in a few days, with excellent as-cast surface finish.

An article similar in scope but giving complete recipes for the aluminum-filled epoxy resin and gel coat is **"Cast epoxide vacuum-forming moulds,"** *Brit. Plastics 30,* 62 (Feb. 1957). Cost of cured casting was reckoned at about 65 to 75¢/lb.

Injection molding

"New gating for acrylics," by ***J. F. Moore,*** reprinted from *SPE J. 13,* 17 (March 1957) in *Plastics* (London), p. 176 (May 1957).

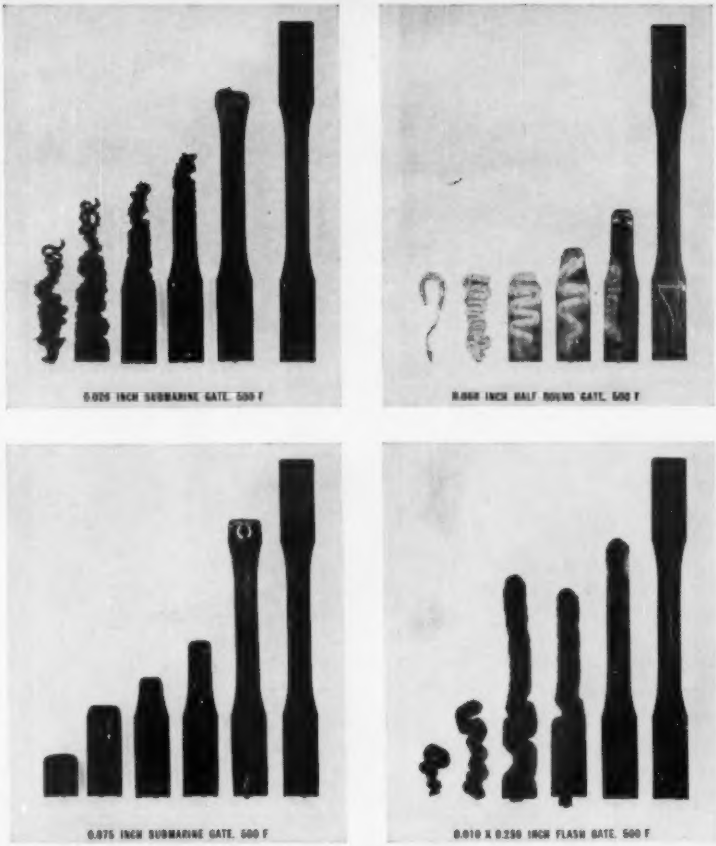
The author presents evidence in favor of "tab gating," in which the gate is located in one side of a tab, or finger, extending from the cavity proper. The hot melt impinges against the opposite wall of the tab; flow is somewhat smoothed by the time it is entering the cavity proper, eliminating the jetting often experienced with direct gating. Advantages: mold need not be packed to fill, strains are reduced, shrinkage is reduced from 4 to 5 mils/in. to 2 to 3 mils/inch. Mr. Moore has also found that "delta-wing" or backswept runner branches are useful where balanced runners cannot be used. Apparently the melt in the main runner will not turn the acute angle into the branch until entire main runner length is filled.

"Thermocouple location and watt density in injection molding heating chambers," by ***R. Dahl*** and ***R. McKee,*** *SPE J. 13,* 42 (Nov. 1957).

A 16-oz. cylinder with three heating zones was drilled to receive six extra thermocouples at points in the same vertical plane as the usual side-located couples, but at points 45 and 90° from the horizontal and 1 in. deep. Control couples were moved from place to place while readings of all were taken; the drilled holes were deepened in steps to examine effects of hole depth, starting at ¼-in. depth. Top temperature is

about 10° F. higher than that at the side. A 4-oz. cylinder was modified (with narrow heater bands and couple wells drilled along the length and around the barrel) to determine lengthwise variations in temperature as a function of control couple location. Findings: 1) best temperature uniformity along barrel = ± 10° F.; 2) temperature distribution is drastically affected by cycle timing; 3) a tight insulated cover reduces lengthwise variation, eliminates round-the-barrel variation, and saves about 25% on power input. Suggestions for good control are made.

One of the weaknesses of our industry, particularly in the smaller shops, is that processors are not very sure of their costs. This situation is evidenced in the wide variation of quoted prices on a single job. Injection molders should find some help in **"Calculation of the unit cost of injection molded pieces,"** by ***J. Combette***, *Ind. d. Plastiques Modernes* *8*, 44 (Dec. 1956) and *9*, 28 (April 1957). In French. M. Combette develops as formula for the unit cost of a molding, assuming it is made on a single machine attended by a single person for *h* hours per day, and that sprues and runners are not recycled. (The formula is easily modified to take in recycling of sprues and runners.) Cost elements such as start-up loss, cooling water, rejects, length of run, length of cycle, finishing costs, and overhead are included, along with direct material and labor, and amortization of machine and mold.



Modes of melt flow into a test-bar cavity fitted with gates of different shapes and sizes. Surface finish depends on mode of flow as well as on filling time. See "Injection molding rigid polyethylene." (Photo, Phillips Chemical Co.)

"Injection molding rigid polyethylene," by ***J. V. Smith*** and ***J. N. Scott***, Modern Plastics *35*, 149 (Sept. 1957), discusses the peculiarities of molding polyethylene of 0.96 density and 0.6 melt index (Marlex 50). In general, recommended conditions are: cylinder temperature between 450 to 550° F. (though best strength is obtained at low temperatures), maximum practical injection pressure and speed, mold temperature between 100 and 200° F. Since this crystalline resin freezes sharply at about 250° F., it can be ejected much hotter than many other resins. Mold design needs careful attention, and it is recommended that the cooling water enter the mold near the cavity gates, leave at the points near those areas of the cavity that are remote from the gate (counter-current heat transfer). Cavities should be gated near the center so as to cause the entering melt to strike a wall, if possible, and gates should be unrestricted.

Air trapped in the cavities of an injection mold causes short shots, burning of the plastic, and bad welds. In **"Vacuum venting of molds"** Modern Plastics *34*, 162 (Dec. 1956), ***G. S. Bohannon*** shows that wide, shallow vents may be milled into the mold face to connect the runners (and through them the cavities) with a vacuum pump. Too shallow and long to let the plastic melt flash through, these vents nevertheless provide ample cross section for rapidly evacuating the air in the cavities just prior to the injection stroke. Any vent flash comes out with the runners, not the piece. Additional cost of mold venting (without pump) is 10% or less.

"Correction of defects in the molding of polyethylene," *Materie Plastiche 23*, 208-10 (March 1957). In Italian.

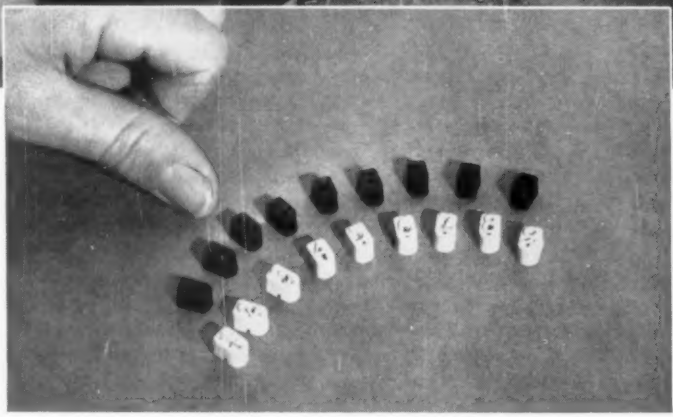
This article is simply a large table containing three columns headed "Inconvenience or difficulty," "Probable causes," and "Remedies." Ten principal ills are listed and given a detailed breakdown.

"Spiral-flow molding," by ***L. Griffiths***, Modern Plastics *34*, 111 (Aug. 1957).

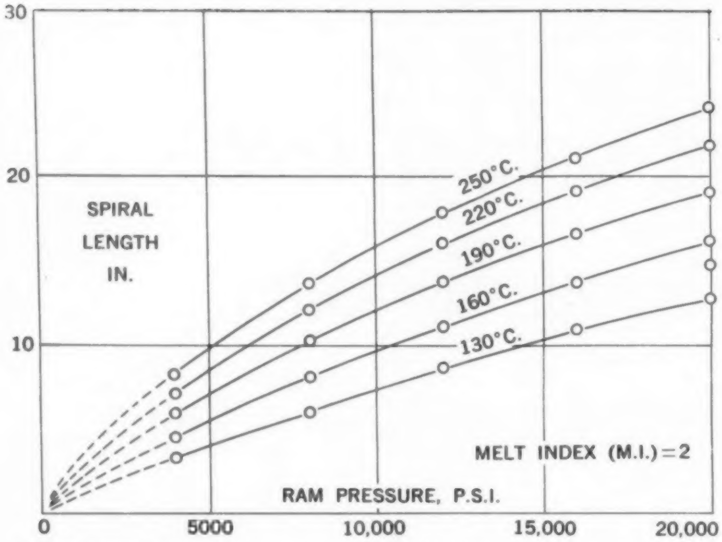
Perhaps the simplest mold cavity that might be made to study the melt flow of plastics under actual injection-molding conditions is a long channel of small and constant cross section

(*To page* 122)

The Stokes Model 701 press installed in the Bristol, Va. plant of Monroe Calculating Machine Company. Operation is completely automatic . . . is unattended except for loading of the hopper and removal of finished parts.



Nine separate pieces are produced at one time. These numerical inserts later have the flush facing molded around them—are used as keyboard buttons on calculating, adding, and accounting machines.



Spiral length versus ram pressure at various temperatures. In spiral mold, a five-fold increase in pressure results in three-fold increase in flow distance; rheological literature shows that in lab instruments a corresponding change in pressure can result in a 50-fold increase in rate. Disparity points up difficulty in applying lab results to injection conditions. See "Spiral flow molding"

that is fed directly by the sprue. Such a mold offering a flow length of 77 in. yet only 9 by 10 in. overall, is described. With proper control of molding factors, particularly the melt temperature, it is possible to comparatively rate the flow of a molding compound with excellent reproducibility. It is also possible to study the flow as a function of molding conditions, and graphs are presented showing results for familiar thermoplastics.

"High-speed injection studies on polystyrene," by ***L. E. Tallman*** and ***O. G. Maxson,*** *Western Plastics 4,* 43 (March 1957).

The authors first present information on rate of injection vs. shot capacity for both single-ram and preplasticating machines, then review the advantages of fast filling. The three chief problems of high-speed filling are: venting, mold rigidity, control of amount of melt injected, with pre-plasticating machines recommended for best control. With such a machine, using a special gate and runner system, it was possible to measure pressure drops at various injection rates through the cylinder and nozzle, the runner, and the gates. Interesting findings: 1) the dependence of pressure drop on flow rate was very different in the three parts of the equipment, being strongest in the gates, weakest in the runners; 2) doubling the land length increased pressure drop only slightly in the gates and runners; 3) the larger the gate, the smaller the rate of change of pressure drop with nominal filling rate. Some of these results might be interpreted in the light of Hahn's findings (see facing page) on the characteristics of injection-molding hydraulic systems.

"Hydrostatic pressure effect on polymer melt viscosity," by ***B. Maxwell*** and ***A. Jung,*** MODERN PLASTICS *35,* 174 (Nov. 1957).

For some time it has been suspected that polymers, being compressible, would have increased viscosities at elevated pressures; but the difficulty of maintaining independent control of static pressure and the differential pressure needed for flow through a hole, over the range of interest to processors, has discouraged experimental verification of this suspicion. In a new double-piston rheometer, the authors have investigated the effect of pressure on the viscosities of polystyrene and branched polyethylene at pressures up to 28,000 p.s.i. Over this range the apparent viscosity of polyethylene increased 14-fold, while that of polystyrene increased 135-fold as the mean static pressure rose from 4000 to 22,000 p.s.i. While the top pressures reached are much higher than those prevailing in molding machines, there has been a definite trend toward higher pressures in injection equipment. For these two materials, injection rates will probably be *reduced* if the applied pressure *on the melt* exceeds about 20,000 p.s.i.

The dimensions and quality of a finished molding depend largely on the conditions in the mold cavity while the piece was being molded. In **"Pressure control for injection molding machines,"** *Plastics Tech. 3,* 459 (June 1957), ***C. E. Beyer*** shows that a pressure transducer in the mold can provide much closer control of piece weight than the best types of feeders. In particular, shot weight was only slightly disturbed by serious variations in other factors (e.g., a 60-sec. interruption of operation). The pros and cons of various locations for the sensitive element are examined, and suggestions are made for putting the pressure signal to work for control purposes.

The pressure transducer used in this work suffers certain disadvantages: it takes up a fair amount of room in the mold and marks the piece or, if used in the nozzle, it is difficult to temperature-compensate. An alternative sensing element, based on crossed strain gages, is the subject of **"Pressure measurement in injection molding by use of ejector pins,"** by ***P. D. Kohl,*** *Plastics Tech. 3,* 629 (Aug. 1957). The author gives considerable clear construction detail for these essentially simple gages, which are used in conjunction with a high-speed recorder. Their finest feature is that they become part of the ejector pin, which has to be there anyway, so they can be used in most standard molds. Pressure is transmitted without moving parts, the readings are sensitive (could detect 25-p.s.i. change in a 15,000-p.s.i. pressure)

and not affected by temperature changes, and the response is very fast. Adapting these gages to measuring nozzle pressures was less successful: bonding problems and failure of lead wires gave trouble.

It has long been recognized that capital cost of injection machines per unit of capacity is very high. A machine capable of shooting only 10 lb. is immense. Sheet thermoforming has already taken over most of the work of making large, thin, relatively uniformly sectioned pieces. Now extrusion molding, i.e., filling the mold with a screw extruder rather than a high-pressure ram, threatens to take over the other function of the big machines—making non-uniformly sectioned, large pieces such as battery cases and shoe heels. The first extrusion-molding machine to be offered commercially is described in detail in **"General-purpose extrusion molding machine."** *Brit. Plastics 29,* 442 (Dec. 1956) and briefly in Modern Plastics *34,* 164 (July 1957).

The machine has already enjoyed some success in molding shoe heels, sandals, and other products. The (at present) air-cooled molds are cheaply cast of aluminum; by sequencing ten molds on a turntable, sufficient cooling time is provided. A 4-in.-diameter extruder, with turntable, can turn out 200 lb./hr. or more of finished moldings—an output comparing with those of 24- to 50- oz. injection machines. And the present model is hardly more than a prototype; its economy of labor and investment can easily be greatly improved.

A constantly reopened question is: "How are properties of molded products affected by molding conditions?" ***C. S. Imig,*** in **"Mold temperature effects in polyethylene molding,"** Modern Plastics *34,* 149 (Dec. 1956), has attempted to supply part of the answer.

The effects of mold temperature on the injection molding of familiar 0.92-density polyethylenes were studied using a four-cavity test specimen mold, a 12-cavity disk mold, and a spiral test mold in a 4-oz. Reed-Prentice injection molding machine. Further work was done on a 20-oz. HPM using a dishpan mold. Poly-Eth 1005, 1007 and 1008.5 with melt indexes of 2, 8, and 23, respectively, were used.

The results indicated that greater strength and stiffness along with faster cycles were obtained at lower mold temperatures. The clarity was also improved although the effect was greater in thinner wall sections using higher-melt-index materials. The surface gloss of the moldings decreased at the lower mold temperatures when using highly polished cavities; no noticeable change could be detected, however, if the cavities were not highly polished. It was observed that in the molding of smaller parts the actual mold surface temperature usually followed the temperature of the circulating water closely. However, in larger molds such as a dishpan mold, the surface temperature was always considerably higher than the temperature of the circulating water, thereby masking the effect of the low temperature. Even so, faster cycle times were always obtained.

"The effect of gating on molding linear polyethylene," by ***F. J. Rielly, V. Hill,*** and ***D. A. Jones,*** *SPE J. 13,* 28 (April 1957).

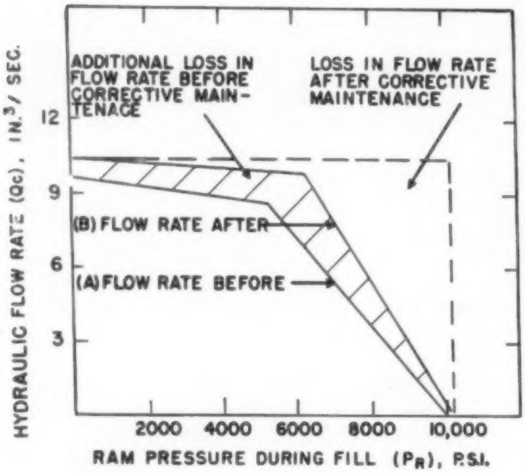
The resin used in this work was Fortiflex A, a Phillips-process polymer. Tensile bars and 3- by 5- by ¼-in. plaques were molded with gates of various sizes and locations, and measurements of impact strength, shrinkage, and warpage were made. Results: impact strength improves with increasing gate size, shrinkage in both length (flow) and width directions increases as gate size is reduced, and balanced multigating may be required to minimize warpage in thin flat sections.

The month of March 1957, saw the beginning of a new monthly feature in the *SPE Journal:* **"Molding Cycles,"** edited by ***Louis Paggi,*** an outstanding authority on the practical aspects of injection molding. Mr. Paggi, drawing on his great store of lore, has offered a wealth of suggestions on such aspects of injection molding as: testing and adjusting heater inputs for good temperature control; using the ram-in-motion time as an indicator of various troubles; nozzle design; mold planning; test cavities; causes and cures of warped parts and surface blisters; and operator safety. Even old-timers can learn from these short, pithy pieces; newcomers to injection molding won't find more pain-saving pages anywhere.

While there is considerable literature on injection molding, there has not been available, prior to the publication of the 1957 Modern Plastics Encyclopedia Issue, a fundamental introduction to the general subject. **"Injection molding,"** the lead article of the Engineering and Methods section of the book, surveys the field from its beginnings to mid-1957, covering, with literature references, such topics as: general operation, feeding, melting the feed, injection, ejection, mold design, pre-drying of powder, annealing, preplastication, and mold temperature control. The 42 references included were selected for their usefulness, both practical and theoretical.

"Relations between the hydraulic system and polymer flow in molding," by ***O. M. Hahn,*** *SPE J. 13,* 25 (July 1957).

In a specially instrumented 2-oz. molding machine it was possible to measure melt pressure at the nozzle and in the mold and pressure and flow rate in the hydraulic system. As melt temperature was raised, three changes in machine performance were noticed that were linked to the hydraulic-system characteristic: 1) polymer flow rate increased up to a certain temperature, then leveled off; 2) higher polymer flow rates were related to higher hydraulic flow rates and lower actual ram pressures; 3) ram pressure was not actually an independent variable, but was inversely dependent on polymer temperature (in these test runs the ram pressure during filling never reached the set pressure). Recommended: 1) instruments on machines that will permit periodic checks of ram pressure vs. ram



Volume flow rate in the hydraulic system of an injection machine dropped suddenly when actual ram pressure reached about 60% of set pressure. Ideal characteristic is indicated by dashed lines. Vertical distance between horizontal dashed line and rate/pressure characteristics gives the flow loss at any given pressure. (Reprinted from *SPE J.*)

advance rate, a practical way of detecting gradual rise of leakage in the system; 2) improved hydraulic-system design to yield sharper flow/pressure characteristics.

General processing

"Short-run plastics parts cast in rubber molds," by ***I. R. Axelrad***, *Materials & Methods 45,* 104 (Feb. 1957).

Where more than three or four prototypes of a plastic part are wanted, machining them out of solid blocks is very expensive. A money-saving alternative consists of machining one "master" from steel, aluminum, or heat-resistant, hard plastic, placing the master between thick layers of uncured Neoprene, pressing this assembly in a compression press, and curing at 300° F. and 800 to 1500 p.s.i. for 20 minutes. The result is a rubber mold suitable for casting phenolic (or other resin) prototypes. Tolerances can be held to about ±4 mils per inch.

Two German articles, **"The Holofol process,"** and **"The Holofol process and its applications,"** by ***W. Opavsky***, appeared in *Plastverarbeiter* for Dec. 1956 and April 1957 (p. 145). This process makes seamless, inflated objects from single (or double) sheets of plasticized PVC and certain rubbers. The process in brief: shapes are die-cut from flat sheeting, the sheets are then partly "hardened" from the outside surfaces inward, either chemically or by evaporation of solvent, leaving a soft core layer. The pieces are then rapidly heated by infra-red, causing gases to be liberated in the core zone; these gases inflate the article and at the same time the "hardening" is completed, so a seamless hollow body results. Typical products: sausage casings, toys, cushions, and gloves. A one-page description, with pictures, ran in *SPE J. 13,* 47 (Aug. 1957).

"Polyester moldings with PVC-sheet overlays," by ***J. Coudenhove-Kalergi***, *Plastverarbeiter 8,* 105 (March 1957). In German.

Business machine housings have been made of vinyl-coated steel, but one maker wanted to use reinforced plastics to get strength/weight advantage. Emulsion-spraying and adhesive bonding of the vinyl were tried and found wanting for this application. The successful process consisted of lining the mold with vinyl sheet and curing polyester and vinyl together. Process is described in detail.

"The properties and fabricating of nylon-11; Part I—moulding powders," by ***F. Chapman***, *Plastics* (London) *22,* 406 (Oct. 1957).

Various molding powder grades are described, and the injection molding of this polyethylene-ish nylon is discussed in detail, covering such points as drying, cylinder design and operation, purging technique, nozzle design (a shut-off type is recommended), molds, shrinkage (about 2% in 0.25-in. sections), and annealing. Mechanical, thermal, and electrical properties are given with some data on effects of moisture and temperature. Applications are discussed and allowable stresses in gears at various speeds are listed.

"Enginering products at the exhibition," *Brit. Plastics 30,* 358 (Aug. 1957).

This is a pictorial review of the machinery, equipment, and tools shown at the 4th British Plastics Exhibition during July, 1957. Among the more interesting were: screw preplasticating injection machines, a small rotary-type injection machine, and the Eck Mixtruder. This issue of the magazine was devoted to the Exhibition and contains a profusely illustrated report on new materials and products, also a short report on the international design display of domestic consumer goods.

"Continuous winding machinery for plastic film and sheeting," by ***J. E. Nordgren***, *SPE J. 13,* 23 (April 1957).

A chain is as strong as its weakest link, and a calendering train is too costly a chain to be hamstrung by a weak-link winder. This article discusses several kinds of surface and center winders, giving pros and cons of each, and helping the film producer to make a wise choice of equipment.

"Influence of process variables on shrinkage of moldings of 'Teflon' polytetrafluoroethylene resins," by ***F. M. Chapman*** and ***L. T. Bunn***, *SPE J. 13,* 37 (Feb. 1957).

Teflon molding cosists of filling a mold cavity with a measured amount of powder, compacting this powder under pressure to a preform, removing it from the mold, heating in an oven to a temperature of about 720° F., and then allowing it to cool to room temperature. The influences of six process variables on the thickness, I.D., and O.D. of a flat annulus and a chevron ring were

measured; the variables were: rate of applying preforming pressure, preform pressure, dwell time under pressure, heating rate, time at sintering temperature, and cooling rate. Results: preform pressure, cooling rate, and sintering time accounted for about 50, 25, and 15% of the variation in dimensions; dwell time, heating rate, and ram speed were relatively unimportant. The results were charted as families of curves which facilitate mold design. Dimensional standard deviations were 2 mils/in. on perpendicular dimensions (diameters, in this case), 3.3 mils/in. on dimensions parallel to direction of pressure application.

"Coloring of polyethylene," by ***F. J. Hines,*** Modern Plastics *34,* 168 (April 1957).

Pigments, rather than dyes, must be used to color polyethylene. For general use, the cadmium-containing pigments, phthalocyanine green and blue, calcined iron oxide, carbon black, and titanium dioxide are recommended. Coloring methods and equipment depend on the quality desired, the most critical applications being wire coatings, film, monofilaments, etc. Tables give the spectral properties of various colorants and the dielectric constants and power factors of colored polyethylenes. Heat stability of colorants *vs.* processing conditions, bleeding of colorants and its determination beforehand, and exudation are discussed.

Vinyl film: Most of our vinyl film and vinyl-coated fabric are made by calendering and extrusion; some has been made by casting on stainless steel belts, but is expensive. Growing in popularity is a new casting process, **"Vinyl cast on paper carrier"** (Modern Plastics *34,* 126, Dec. 1956), in which a special paper is the casting base. The inherent versatility of formulation allowed by the process, plus the low capital investment needed, are its great attractions. Other favorable factors are: variety of widths and finishes possible, elimination of blocking, simplicity of multiple passes, nonstretch coating of stretchable fabrics, extreme thinness of film when desired, any thickness in one pass, and economy of both long and short runs. Equipment, resins, plasticizers, and curing conditions used are discussed.

"Effect of blow-up ratio on properties of polyethylene blown film," by ***C. G. Kucher,*** *Plastics Tech. 3,* 711 (Sept. 1957).

The results of this experimental study on two polyethylene resins of density 0.920 and 0.925, over the range of blow-up ratios from 0.5 to 5, show that as blow-up ratio increases, properties in both the extrusion direction and the transverse are significantly changed, some increasing with blow-up ratio, some diminishing. Slip value was unchanged. At a blow-up ratio of about 3.5, tensile strength and elongation in the extrusion direction were equal to those in the transverse direction, though the tear strengths equalized at about 1.7 blow ratio, and impact strength (non-directional) rose linearly over the blow-up range. There were significant differences in the performances of the two resins.

A 67-page symposium in *Industrial and Engineering Chemistry* for Nov. 1957, entitled **"Engineering aspects of polymer processes,"** deals mostly with polymerization processes. The two papers of greatest interest to plastics processors are **"Mixing in laminar flow systems,"** and **"Theory of mixing in the single-screw extruder,"** both by ***W. D. Mohr, R. L. Saxton,*** and ***C. H. Jepson.*** The first lays the groundwork for the second. We quote from their abstracts: 1) "The concept that the mechanism of mixing is the generation of new interfacial surfaces by shear permits goodness of mixing to be related to the amount and orientation of the initial interfacial surface and the net shear strain imposed. The calculation was carried out for an initial system of discrete cubes. For this case the effect of differences in viscosity between the components was derived." 2) "Equations were derived to relate mixing performance to screw geometry and degree of pressure flow. The zone of poor mixing found near the mid-radius of extruded rod is predicted by the theory. The calculated goodness of mixing improves with decreasing helix angle, increasing thread depth, and increasing pressure flow. The last effect agrees qualitatively with experiment."

"Significant variables in plastic container fabrication," by ***R. J. Lee*** and ***J. W. Mighton,*** *Western Plastics 4,* 19 (July 1957).

Injection molding and sheet thermoforming are compared as processes for making thin-walled containers from polystyrene molding powders. Factors considered are: technical difficulties and limitations; influence of process on finished product design, appearance, properties, and post-finishing; and capital investment and direct labor required. Authors conclude that for a given production rate of about 160 p.p.h. of finished containers, investment is $380/p.p.h. for molding, $420/p.p.h. for extrusion-forming, and molding can be done by one man while extrusion-forming needs two. Estimates are based on round containers with a 50% trim regrind rate in forming, unstated regrind rate in molding.

Extrusion

"Extrusion," the opening article in the extrusion chapter of the 1957 Modern Plastics Encyclopedia Issue, is a fundamental introduction to the subject. An attempt has been made to summarize the available information on these aspects of the process: feeding, melting, metering, melt flow theory, screw design, power requirements, adiabatic extrusion, die design, mixing, extraction-extrusion, and instrumentation. A bibliography is appended.

"Factors affecting quality in polyethylene extrusion," by ***B. H. Maddock,*** Modern Plastics *34,* 123 (April 1957).

Extrudate quality, which ranks in importance with output rate, has two bases: dimensional uniformity and mechanical homogeneity. The effects of design and

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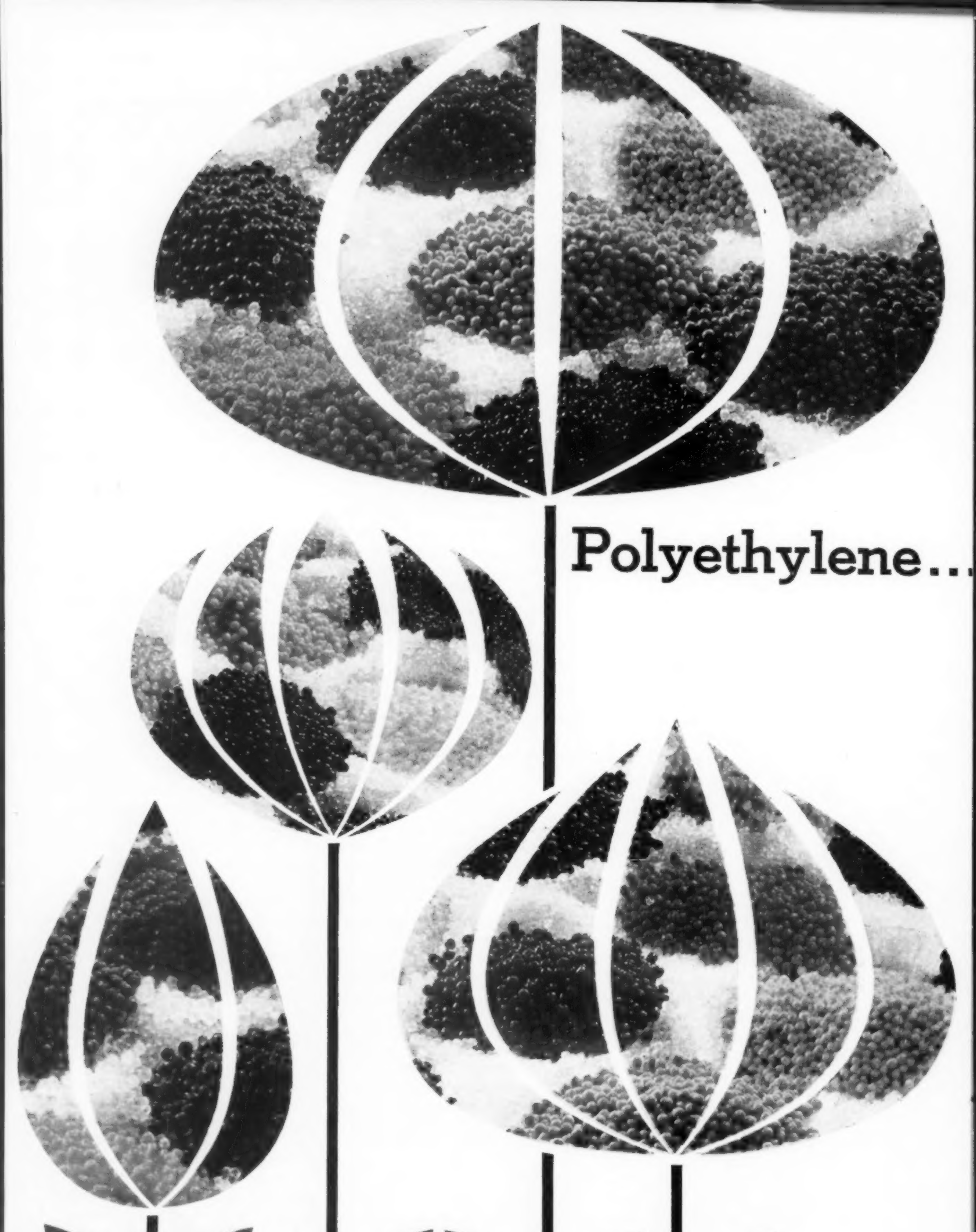
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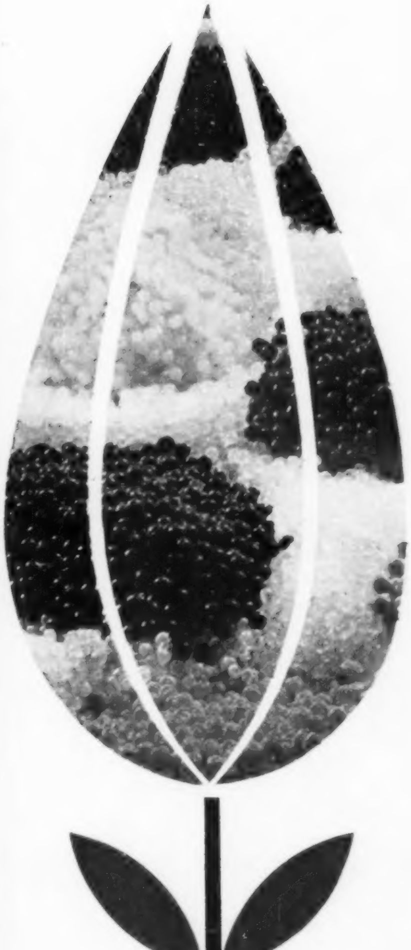
... fastest growing plastic of all time



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Originally a dull, milky-white material, polyethylene has been given a colorful new dimension by Eastman. Today, molders and extruders can order pellets of Tenite Polyethylene in almost any color desired. For Tenite Polyethylene has profited by Eastman's long experience in the coloring of Tenite Acetate and Tenite Butyrate—two other Eastman plastics.

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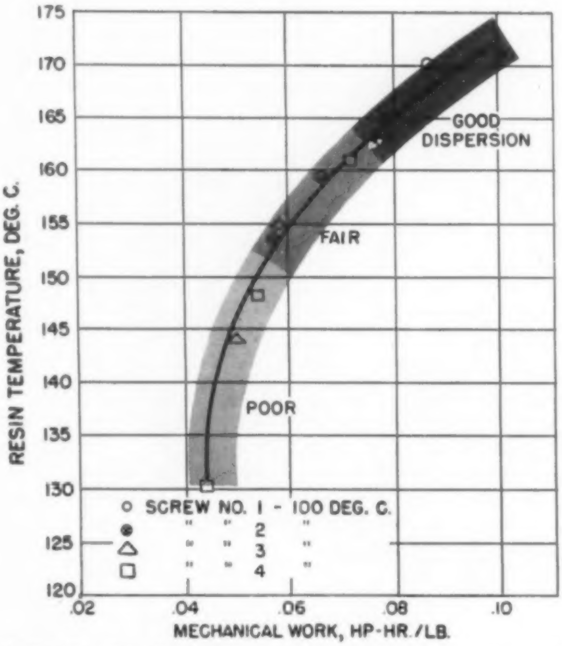

"Map" of melt temperature and mechanical working. Resin temperature attained in all four screws is about the same, and quality improves with increasing working and temperature. See "Factors affecting quality in polyethylene extrusion"

operating factors on both these aspects of quality have been examined experimentally in 2-in. extruders, using polyethylene of melt index 2. The results suggest that the product of shear rate and dwell time, or the amount of shear, may be a fundamental factor governing the thoroughness of mixing. In general, extrusion quality is shown to be improved by increasing the back pressure (which reduces output), by increasing stock temperature, or by increasing the amount of mechanical work per pound of plastic. The ability (of operator and machine) to maintain the last two of these factors at satisfactory levels determines the ultimate useful output.

Two articles of interest to designers of extrusion dies appeared in *J. of Applied Physics* for May, 1957. One, **"End correction in the capillary flow of polyethylene,"** by ***E. B. Bagley***, p. 624, adjusts the usual flow equations to take account of the fact that the pressure drop across an orifice of essentially zero length is much larger than the kinetic energy gain would warrant. The correction amounts to assuming that a zero-length orifice has an "effective length" of from 1 to 10 radii, depending on the shear rate. Since the dependence of the number radii, *n*, on the shear rate is not simple, it won't be easy to utilize this correction method in design; however, if *n* is assumed to be about 5, a simple formula results that is much better, for most die design work, than one assuming n=0. Results apply only to certain polyethylenes, but, since the physical effect is observed with other resins, the same method will probably be useful with them, too.

The other article, **"Hydrodynamic theory for the flow of a viscoelastic fluid,"** by ***Y. H. Pao,*** offers a system of equations that can be used to predict the flow of polymer melts from their easily measured spectra of retardation or relaxation times. The theory is extremely complex to apply: the calculation of pressure-flow rates through a round tube, the simplest of all die-flow problems, required the use of a UNIVAC computer, and the results showed only fair agreement with rates determined experimentally. However, the theory has great power and, with the increasing availability of high-speed computers, may eventually attack an aspect of die-design that has so far not been touched theoretically: the effects of the "elastic memory" of the melt on the extrudate shape and dimensions.

R. E. Gee and ***J. B. Lyon,*** in **"Nonisothermal flow of viscous non-Newtonian fluids,"** *Ind. Eng. Chem. 49,* 956 (June 1957), have advanced another step in the solution of the problem of flow of viscous (but not elastic) melts through tubes with heated or cooled walls at rates high enough so that heat developed by viscous working significantly influences viscosity. The Joule-Thomson effect and point variations in thermal properties are also included, but convection is neglected. The tube is assumed to be full of melt when flow starts (in contrast to the start of flow in the runner system of an injection machine). Here also the amount of numerical work was immense, requiring an IBM-794 computer, but again there is hope that simple generalizations may be drawn from the results of many such calculations and their logical extensions (unfilled tubes, runner-gate-cavity systems). And there is already some meat here for extrusion die designers.

"High speed screw extruders," by ***E. Beck,*** *Brit. Plastics 30,* 441 (Oct. 1957).

Mr. Beck represents Alpine A. G., the first company to offer processors high-speed extruders with unheated barrels—the necessary heat is supplied by the screw, and for a given resin, die, and screw speed, the operation is self stabilizing. Equations giving the output of such an extruder in terms of screw speed, screw diameter, allowable stress in the screw, and resin characteristics are presented, along with the author's empirically established scale-up rule: linear peripheral speed of the screw should equal a certain value characteristic of the resin, no matter what the size of the extruder. The effect of this rule is to make the system most profitable in the smaller-size-

machines. Experimental results obtained with many thermoplastics extruded into a variety of sections (e.g., film, monofilament, tubing) on extruders of three sizes are given. Speeds ranged from 250 r.p.m. on the 2.6-in. machine to 1500 r.p.m. on the 0.7-incher, which delivered about 10.5 lb./hr. of polyethylene shape at this speed. Principal advantages of system: 1) eliminates gear reducer and barrel heating equipment; 2) eliminates large temperature differences in hot resin; 3) greatly reduces dwell time at temperature, because rate is high for extruder size and resin is not melted until the last turn or two of the screw. Much the same information, by the same author, but in German, was contained in two articles appearing in *Kunststoffe* for January 1956 and *Plastverarbeiter* for January 1957.

"Extrusion of polycaprolactam nylon," by ***R. R. Von Toerne,*** Modern Plastics Encyclopedia Issue 35, 721 (1957); **"Extrusion of nylon 6,"** by ***R. L. Hughes,*** *Plastics Tech. 3,* 463 (June 1957).

These two articles overlap considerably in content; both are practical guides to the extrusion of the relatively (in U. S. extrusion) new type 6 nylon. Von Toerne has given more information on screw design and extrusion conditions, while Hughes has included information on physical properties of extruded films and pipe.

"Polyethylene extrusion coatings," by ***H. A. Arbit, E. E. Griesser,*** and ***W. A. Haine,*** *Modern Packaging 30,* 142 (Apr. 1957).

This thorough study of the coating of foils, papers, and cellophane with polyethylene led to these conclusions: Adhesion of polyethylene to substrate is improved by 1) high melt temperature, 2) freedom of substrate from moisture, lubricants, powders, 3) pre-heating the substrate, 4) preprocessing of polyethylene, 5) slow quenching of laminate, 6) post heating of laminate. Factors adversely affecting adhesion were: 1) opposites of above, 2) excessive amounts of anti-oxidants in resin, 3) high coating speeds. Adhesion was not affected by 1) small amounts of anti-oxidants, 2) pressure changes of rubber back-up roll, 3) molecular weight of adjacent grades of resin.

Reinforced molding

"What about 'membrane molding'?" by *J. Love,* Modern Plastics *34,* 144 (March 1957).

Membrane molding is a bag-molding process in which the bag, instead of being fabricated of flat sheets of rubber which wrinkle during molding, is made of form-fitted polyvinyl alcohol. The difference is "roughly comparable to the difference between a gunny sack and a bikini." Moldings of good clarity, low voids, high glass content (up to 70%), and high mechanical properties (flexural strength and modulus after 2-hr. boil of ⅛-in. test panel with 13 layers of glass cloth and 30.6% Selectron 5003 were 80,200 and 3.42 x 10^6 p.s.i. respectively) were obtained.

"Developments in reinforced plastics," *Brit. Plastics 30,* 227 (June 1957).

This is a report of the technical conference on reinforced plastics held by the British Plastics Federation in May 1957. Topics covered include: thermal decomposition, heat-resistant laminates, glass finishes, effects of heat on flexural strength, materials for polyester production, asbestos reinforced materials, matched metal die molding, injection molding of reinforced plastics, dough molding, autoclave molding, inspection of laminates, fatigue and creep properties, pressure vessels, reinforced plastics in aircraft construction, and medical aspects.

"Pressure preforming," by ***S. H. A. Young,*** Modern Plastics *34,* 161 (March 1957), describes a slurry process for preforming the glass and cotton (or other fiber) that is subsequently impregnated with resin and heat cured to make a reinforced plastic product. Preforming takes place on a perforated metal form, or screen, through which a well-mixed slurry is forced under moderate pressure, rather than by vacuum (one atmosphere pressure), as in the Hawley process. Process offers: high preforming rates, simplicity in producing wide and sudden variations in section thickness, excellent physicals in finished product, and economy in long runs. Tooling costs are relatively high.

"Estimating for reinforced plastics," by ***F. W. Sheffler,*** Modern Plastics *34,* 135 (May 1957).

Competitive, profitable operation and satisfaction of the customer in the reinforced plastics fabricating business depend heavily on sound estimating procedure. A good estimate should define the product, provide reliable prices and delivery dates, and guide manufacturing personnel. Carefully developed estimated forms (samples are shown) improved the reliability of estimates and provided records. Labor estimates should be based on a definite, visualized plan of operations; they may be checked by formulas that abstract past experience in the basic operations.

In all reinforced-plastics work there is an initial "learning" period during which the amount of labor per unit decreases steadily to a final constant value. Most of what is learned is retained from order to re-order on the same job and can be passed on to other workers. Learning curves based on past performance records on similar jobs provide a valuable basis for estimating start-up labor loads.

To be most effective, the estimating group should report directly to top management.

"Rubber tools for reinforced molding," by ***R. Thompson,*** Modern Plastics *34,* 115 (July 1957).

Many reinforced plastics objects which have required matched metal molds may now be made in molds that are half metal, half rubber. The rubber "mate," which can be either the male or female half, is cast from heat-resistant silicone rubber. As the mold closes, the mate deforms and forces the molding compound, usually a preimpregnated

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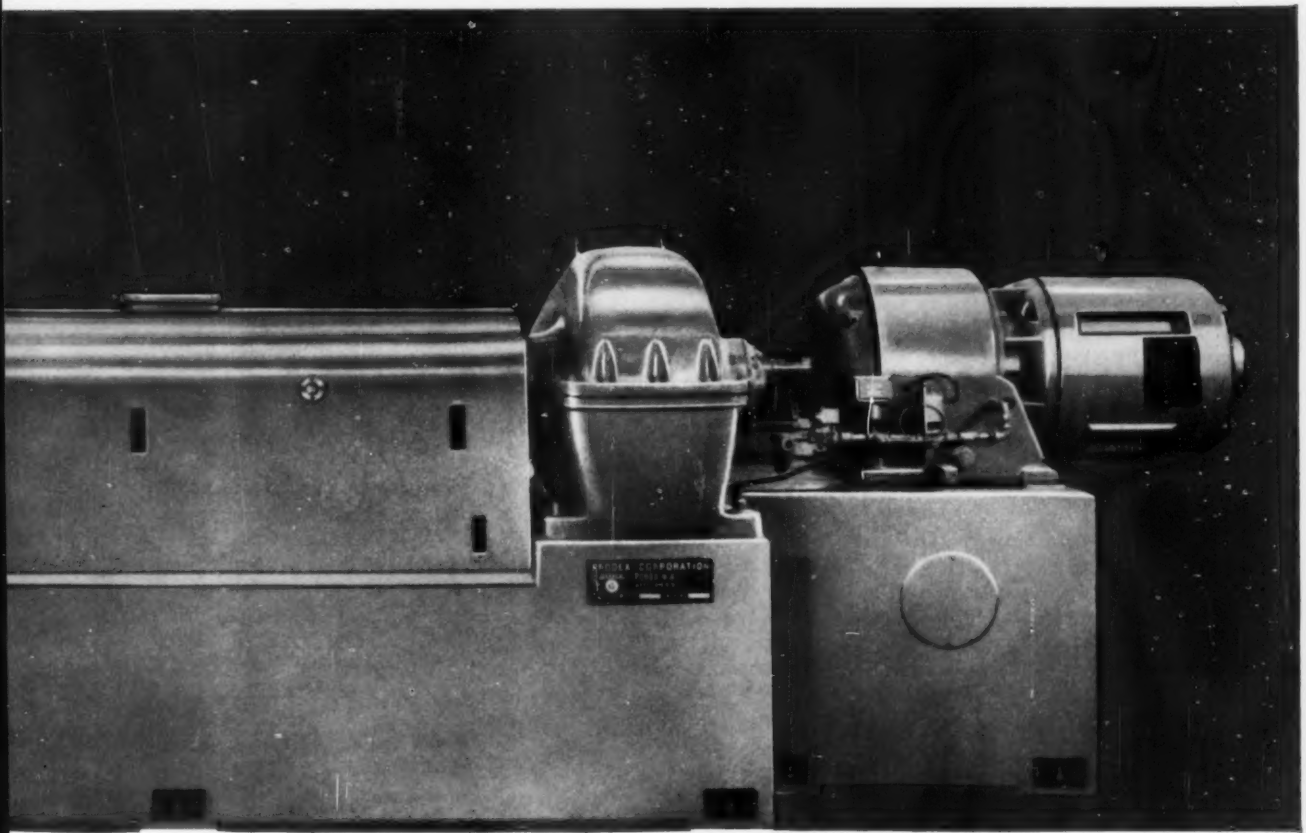


glass fabric, to assume the shape of the metal half of the mold. The process may be thought of as a very-high-pressure bag molding process in which rubber compression does the work of the usual air pressure.

Resin reinforcement is usually accomplished by fibers and, to a minor extent, by some fine-particle fillers. The article, **"Glass-flake laminates,"** by ***G. Rugger***, *SPE J. 13*, 35 (April 1957), introduces flakes as a new form of reinforcement. Very high percentages of glass—about 80% —are possible, and the expected ultimate price of the flakes is about 14¢/pound. Thus, glass-flake laminates may become one of the least expensive of plastics. While flexural and tensile strengths are comparable to those of 40% glass-mat laminates, the moduli are high, about 4.5 million p.s.i.—in a class with those of the uni-directionally fiber-reinforced laminates. Vibrating-reed tests indicate a much higher viscous component of modulus for glass-flake laminates than for their glass-fiber counterparts, and a higher mechanical loss factor; these results imply that the glass-flake material will stand up better under impact and vibration. Much more work needs to be done on this exciting new form of reinforcement before its capabilities are well defined.

"The molding of thick polyester laminates," by ***F. Claudi-Magnussen***, *SPE J. 13*, 36 (March 1957).

An experimental study of exotherms in 35% glass laminates with Hetron 92 and styrene monomer, ranging in thickness from 0.25 to 1 in., yielded these conclusions: ". . . An important cause of internal delamination in thick laminates is the high peak exotherm temperature obtained in the interior of the panels. This exotherm can be lowered by decreasing the catalyst concentration, lowering the platen temperature, increasing the filler content, and the judicious use of chain transfer agents or chain stoppers, all of which must be compromised with the economical need for shortest possible molding cycles. The use of catalysts with slower decomposition rates appears to be another possibility for obtaining lower exotherms. . . ."

Thermoset molding

"The transfer molding of curable plastics," by ***H. Spies***, *Plastverarbeiter 8*, 100 (March 1957). In German.

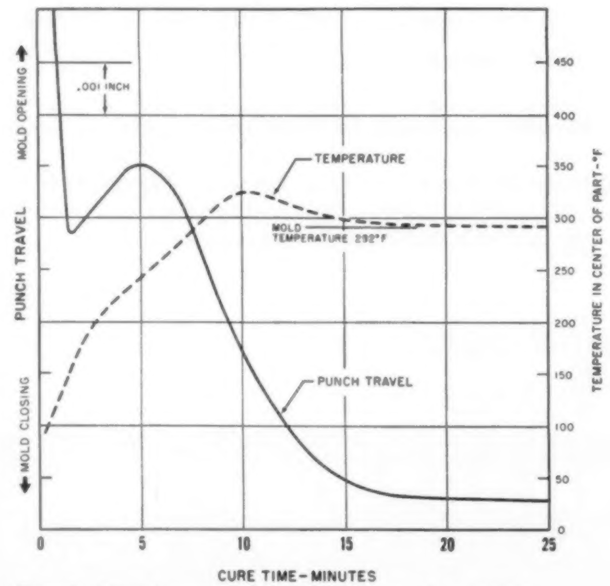
The author lists the pros and cons of transfer molding relative to compression molding. Design of transfer molds is discussed. Many clear drawings are included.

"Volume and pressure effects in compression molding," by ***W. R. McGlone*** and ***L. B. Keller***, MODERN PLASTICS *34*, Part I: p. 173 (March 1957); Part II: p. 137, (April 1957).

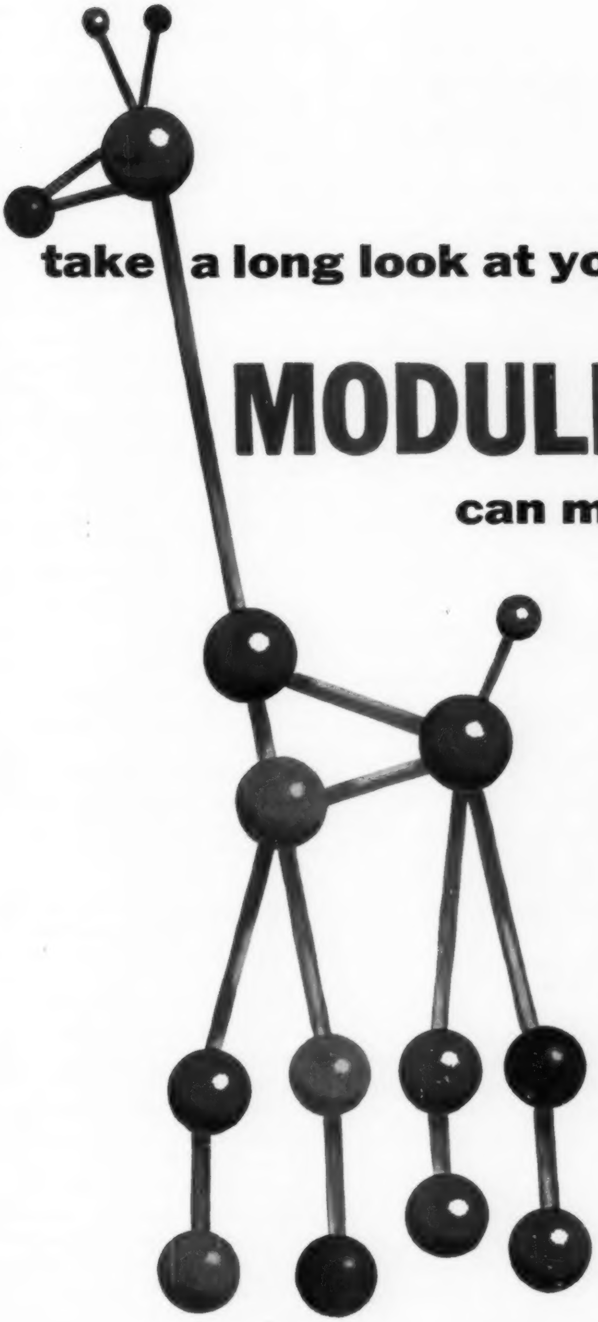
In this experimental study, the volume of a disk molding is followed over the molding cycle at constant pressure in an unlanded positive compression mold (Part I), and pressure was measured at constant volume in a landed positive mold (Part II). Eleven phenolic and polyester resins were investigated, with punch travel-vs.-cure time being given for all 11, and for some of them at different charge weights and pressures. Punch-travel curves reflect the character of the material and are a quantitative guide to what is going on in the mold during the cure cycle. In a landed mold, high effective pressure on a part alone does not ensure a non-porous structure, though it helps. The use of slow closing, dwelling and bumping, preheating of material, etc., may be necessary to make non-porous parts.

"Shrinkage of thermosets," by ***A. J. Guzzetti***, MODERN PLASTICS *34*, 111 (Feb. 1957).

Molding shrinkage is governed by three mechanisms: thermal contraction, elastic recovery from compression (which tends to reduce shrinkage), and plastic deformation. These in turn are dependent on three classes of variables: molding factors, mold and piece design, and material characteristics. In general, molding shrinkage increases as mold temperature rises, as preheat temperature falls, as cure time lengthens, as applied pressure is raised, with faster ejection, and with increasing cooling rate. Increasing the gate size in plunger molding reduces shrinkage because of better pressure transmission. Thinner pieces, because they



Punch travel and center temperature of specimen during compression molding



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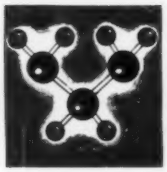

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attain a greater degree of cure than thick pieces under normal molding conditions, suffer less shrinkage. Several material factors are associated with coefficient of expansion, and, of course, shrinkage increases with increasing expansion coefficient. Fillers may affect it either way, while plasticity and moisture content increase with the expansion coefficient and shrinkage. The magnitudes of these effects are shown in 19 graphs.

Calendering

"Causes and control of calender roll plating of vinyl compounds," by ***L. G. Howard*** and ***R. C. Hess***, *Plastics Tech.* 3, 887 (Nov. 1957).

"One of the most critical problems encountered in calendering film and sheeting is 'roll plating', a severe coating deposited on the calender rolls under certain processing conditions." A test of deposit formation was developed, and tests of plating as influenced by various elements of composition were made. Results: 1) plating is proportional to barium/cadmium concentration, barium having the greater effect; 2) some pigments increase plating; 3) vinyl resins and chelating agents (in normal concentrations) have no effect; 4) stearic acid and fillers reduce plating, one by lubrication, the other by scrubbing. The findings have helped in formulating compounds for reduced plating.

"Designing better calenders," by ***K. J. Gooch***, MODERN PLASTICS *34*, 165 (March 1957).

The trend in calendering machinery has been toward greater versatility: processors want to be able to make a wide range of thicknesses in a range of compositions on a single machine. The author discusses the recent developments in machine design that have contributed to this trend. Much of the discussion centers on the control of thickness in the transverse direction, which is made difficult by the bending-apart of the rolls under the calendering forces. The author shows mathematically that the bending compensation curves obtained by direct roll counter-bending and by roll crossing are identical.

Fabricating and finishing

"New test for tool wear in machining thermosets," by ***A. P. Landall***, MODERN PLASTICS *35*, 143 (Oct. 1957).

The test described removes the element of personal opinion in rating thermosetting materials as to tool wear. It consists of drilling a series of holes in molded samples under constant load and determining the difference between the times required to drill the last and first holes. Averaging the differences for four series of holes gives the tool wear index (TWI) in seconds, with 95% confidence limits of ±10 percent. Several years of field experience have borne out the validity of the test. The use of the TWI in studying factors contributing to cutting tool wear and in developing low-wear molding compounds is demonstrated.

"Factors affecting the heat sealing of polyethylene film," by ***R. M. Knight*** and ***W. U. Funk***, MODERN PLASTICS *35*, 133 (Dec. 1957).

A satisfactory heat seal may be defined as one that is at least as strong as the film it joins. Other factors being fixed, there is a range of sealing times that will yield satisfactory seals at a given sealing temperature. Both the mean sealing time and the operating range decrease as temperature rises, so that top productivity requires close attention to process control. At a given temperature, the required clamping time decreases as sealing pressure or resin melt index increases, or as density or film thickness decreases. Increasing pressure or density also narrows the operating range. Over the practical concentration range, slip additive has no significant effect on the boundaries of the operating region. Sealing gusseted film requires close attention to conditions if good seals are to be made; some lengthening of cycle time (over that required to accommodate the extra thicknesses) is advisable in the interest of control of seal quality.

"Swing-arm die-cutting machines and shape formulas for the plastics industry," by ***H. Gut***, *Plastverarbeiter* 8, 262 (July 1957). In German.

The author states that the force required to die-cut a given shape from a given plastic sheet is equal to the perimeter of the shape times the sheet thickness times the shear strength of the material. With the aid of sketches, he shows how the perimeters of shapes made of straight lines and circular arcs may be calculated. Two German die-cutting machines developing maximum forces of 8000 and 16,000 kg. are described, and an equation presented that can be applied to determine feasibility of cutting certain shapes with these machines.

A detailed, step-by-step description of the process of silk-screen printing on plastics is presented in a series of articles entitled, **"The silk-screen process,"** by ***E. Mertes***, that appeared in *Plastverarbeiter* from April to October, 1957. In German.

"Sawing and machining glass-reinforced plastics with diamond-coated tools," by ***L. H. Barron***, *Plastics Tech.* 3, 467 (June 1957).

Glass-reinforced plastics are extremely abrasive, and diamond-coated tools frequently offer production economies over other cutting media in working these materials. The author describes the construction and characteristics, including shapes available, of cutting tools made of diamond-coated steel. An assortment of short case histories of plastics fabrications are presented in sufficient detail to give someone unfamiliar with these tools an appreciation of their possibilities.

"Color variations in coatings for plastics," by ***M. A. Self***, *Plastics Tech.* 3, 277 (April 1957).

Color variations in coatings on plastics are usually caused by

ANNOUNCING the PE-175 molding machine by WATSON-STILLMAN

This latest addition to the Watson-Stillman line of preplasticizing type injection molding machinery has the design features, speeds and flexibility you need to take on a multitude of molding jobs. And it is W-S engineered to give you extra years of high production service.

The PE-175 is available in long or short stroke designs. It can also be furnished without the preplasticizing unit as a straight shooting 48-ounce machine.

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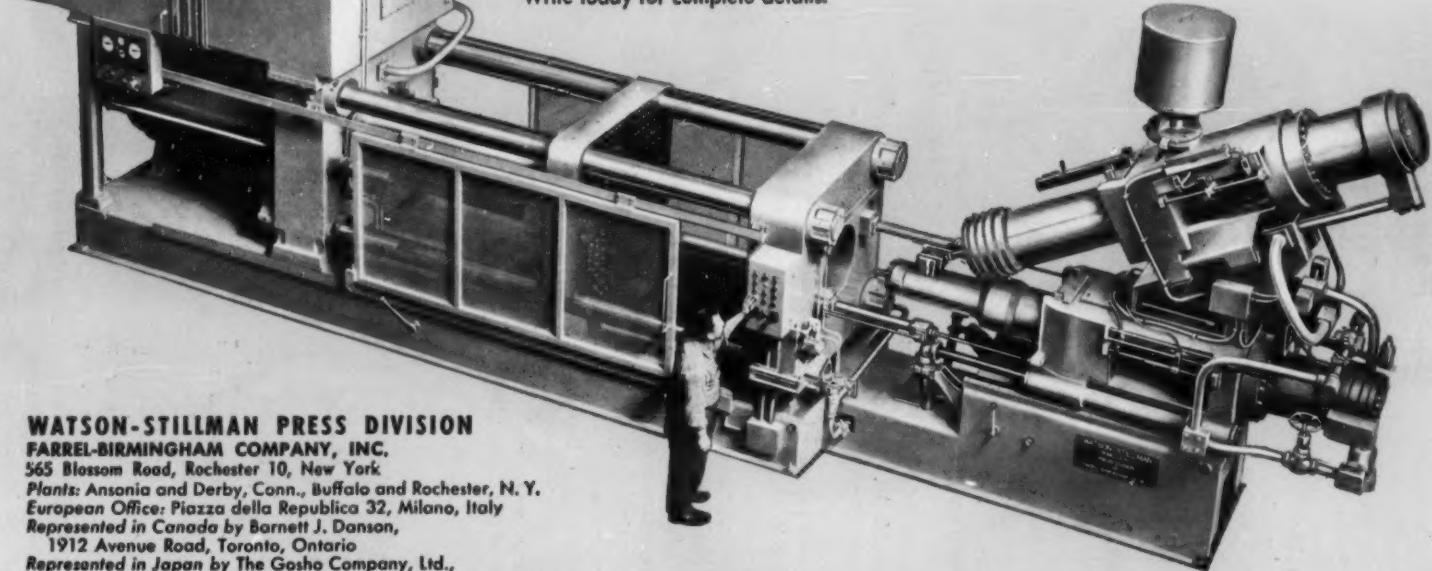
SPECIFICATIONS (long stroke machine):

Maximum amount of material per shot (styrene)	175 oz.
Capacity of feed	166 cu. in.
Plasticizing capacity of cylinder per hour	550 lbs.
Clamping capacity	1000 tons
Stroke of clamping ram	66"
Daylight opening	108"
Maximum die size	40" x 60"
Pressure on material	21,000 psi
Injection rate	3350 cu. in./min



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one of the following: 1) poor application technique, 2) changing or variegated color of substratum, 3) color matched to the wrong surface, 4) surface design variations, 5) color bleeding, 6) etching, 7) incorrect light used to check color, or 8) change of standards. The author discusses the various problems in these classes and makes suggestions for solving them.

"Design hints for laminated plastics," by ***G. A. Ebelijare,*** *Product Eng.* *28,* 186 (Jan. 1957), is a collection of clear diagrams illustrating recommended design gimmicks for articles to be machined and punched from cloth and paper high-pressure laminates. Since these materials are definitely not isotropic, suggestions are made for orienting them with respect to applied loads of several kinds. Fastening techniques are given, too.

"An improved laboratory heat sealer," by ***K. W. Ninnemann,*** *Modern Packaging,* *31,* 171 (Nov. 1957).

The sensitive instrument described here is capable of simulating the full range of sealing conditions encountered in high-speed machines. The article contains much interesting information on the measured effects of processing variables on heat seal strengths of cellophane and polyethylene films. The instrument, whose relatively simple construction is given, was developed in the laboratory of a large film producer.

Designing with plastics

"Design and fabrication with directionally reinforced plastics —I," by ***A. L. Donaldson*** and ***R. B. Velleu,*** MODERN PLASTICS *35,* 133 (Oct. 1957).

Directionally reinforced molding materials make it possible to develop, even in complex structures, a pattern of strength corresponding closely to the expected pattern of stress in service. Thus the designer need not pay a weight penalty for unwanted strength in random directions, as with isotropic materials. Tensile strengths up to 120,000 p.s.i. are possible at tensile moduli up to 5.9 million p.s.i., and lot-to-lot uniformity of properties is excellent. Because these reinforced epoxies are not sensitive to environmental conditions, abrasion, notch effects, etc., the strengths realized in service approach the laboratory values.

Typical design applications are discussed in Part I of this article. Part II, which appeared in the November issue, dealt with the molding and fabrication of these materials.

An excellent review of the properties, suggested applications, cost, etc., of PVC pipe and fittings, in which this plastic is compared with metal pipe, appeared in *Chemical Engineering,* Nov. 1957, p. 296: **"Process piping . . . plastics vie with metals,"** by ***J. P. Kelleher*** and ***C. L. Mantell.*** Lists of available sizes of pipe and fittings are given and there are tables of working pressures at various temperatures. A table comparing the per-foot costs of 0.5- and 1.5-in. pipe of two PVC's and nine common piping metals shows that PVC pipe is considerably less costly than lead, red brass, 304 stainless, Monel, or 316 stainless piping; thus, where corrosion resistance is needed, and temperature/pressure requirements are not severe, PVC pipe is a logical choice.

The acceptance of plastics as engineering materials of construction has been severely hampered by the meagerness of engineering design data. A big step in the evolution of an industry-wide Plastics Design Handbook is the compilation by Du Pont of design and engineering data on its four principal plastics: polyethylene, nylon, acrylics, and TFE. These books, running to some hundred 9- by 12-in. pages each, contain clearly presented data on strength, creep, fatigue, impact, and hardness of each material, including the known effects on these properties of temperature and humidity. Resistance to many chemicals, and electrical and optical properties are given. The 10 pages of graphs showing the effects of temperature and moisture content on the electrical properties of Zytels 33 and 101 are typical of the thoroughness of the work (already being revised to include new data). Two chapters in each volume deal with miscellaneous properties and fabrication techniques.

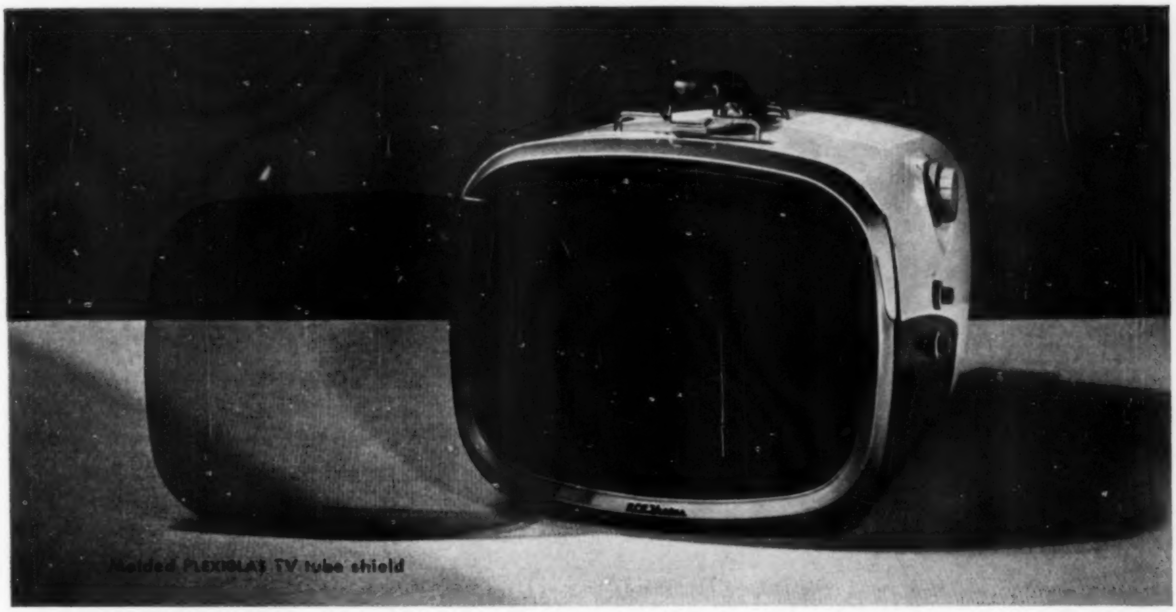
The handbooks are not yet available for general distribution, but it is expected they will be soon.

"Plastics drawers," MODERN PLASTICS *35,* 114 (Oct. 1957).

Largely experimental until only three years ago, plastics furniture drawers are expected to consume 1,500,000 lb. of various plastics in 1957. Advantages over wooden drawers include: 1) jointless, one-piece construction; 2) dimensional stability; 3) smooth, snagless surfaces; 4) molded-in colors; and 5) ease of cleaning. Materials, production methods, and design features of available types are listed and profusely illustrated. The advent of plastics drawers has caused a change in furniture design viewpoint: instead of designing the drawers to fit the furniture, the designer does the opposite, to permit long runs of an economically reasonable number of types. In addition, drawers can be molded to serve specific functions.

"Stability of nylon parts in business machines," by ***B. W. Nelson,*** *SPE J.* *13,* 13 (Feb. 1957).

Gears made of type 6/6 nylon were wear-tested in contact with mating gears made of nylon, aluminum, and steel at three tooth loads. Measurements of changes in the dimensions of bone-dry gears exposed to various humidity conditions for 40 weeks were made. Results: 1) nylon gears can be used at tooth loads up to 130 lb./in. of tooth width; 2) nylon appears to wear well against either nylon or steel, but should never be used with aluminum; 3) steel working surfaces in contact with nylon should have a finish of 30 μin. or better and be free of burrs; 4) dimensional changes are small (2 mils/in. or less) at relative humidities up to 50%, but



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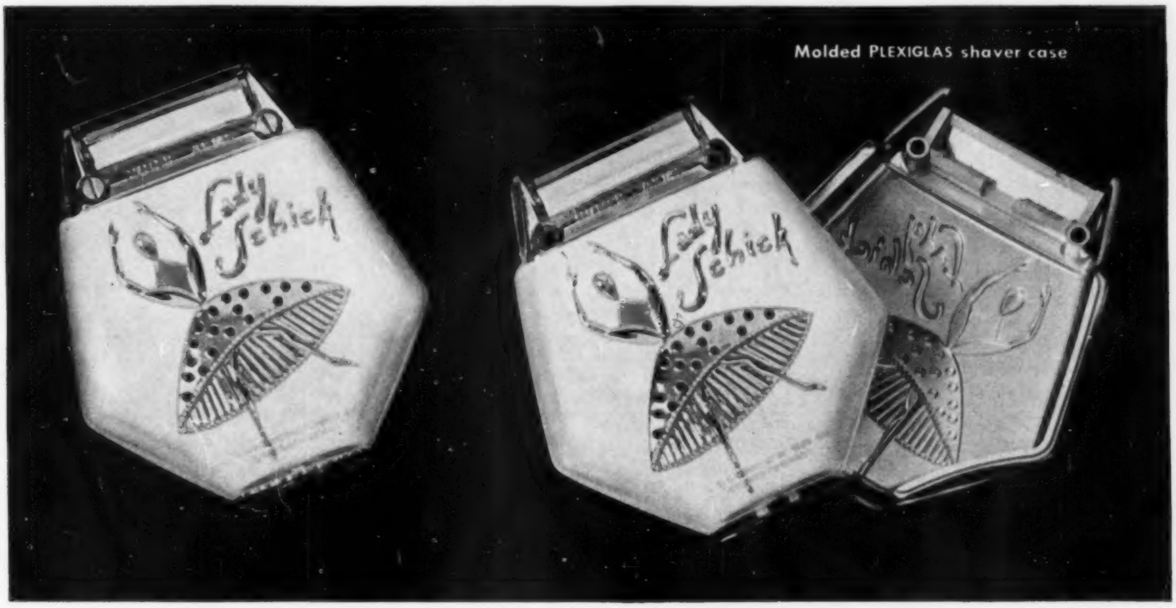

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increase rapidly to 20 mils/in. at 100% R.H.; changes are reversible; 5) where ambient humidity is high and/or annually variable, dimensional changes can be minimized by designing parts of nylon-surfaced metal rather than of solid nylon.

"An approach to the design of glass reinforced structures," by ***P. H. H Bishop***, *Brit. Plastics 29*, 415 (Nov. 1956).

Designers of complex and large structures, (e.g., boats) find it difficult to predict deflections and stresses beforehand, and the difficulty and attendant risk of costly error have resulted in 1) gross overdesign and 2) abandonment of projects. With large reinforced plastics structures, however, it is easy to make a proper scale model of the proposed structure. If all the dimensions in the model are scaled down from the full-scale structure by a factor N and the loads are scaled down by N^2, then the stresses in the model will equal those in the structure-to-be and the deflections will be $1/Nth$ as great. Simplifications of the models are possible under certain circumstances. Chief drawback: there will be no correspondence between joint failures in model and structure.

"Effect of fillers in polyethylene," by ***W. J. Frissell***, *Plastics Tech. 2*, 723 (Nov. 1956).

A medium-molecular-weight, low-density polyethylene with a melt index of about 2, was blended with each of 26 fillers in several concentrations up to 50% filler and molded into plaques from which test specimens were cut. Physical testing included tensile properties at 23 and 80° C., heat distortion, secant modulus, zero-strength time, hardness, and guillotine cut test. At the 5% filler level, the compounds were little different from the unfilled resin, but at 20% and higher levels there were pronounced effects. Fillers reduce elongation, but improve performance in most other tests. Tensile and yield strengths are improved by some fillers, unaltered by others, diminished by others. Outstanding improvers are silane-treated, 0.5-in. glass fibers, glass film flakes treated with phenolic resin or vinyl silane, mixed asbestos fibers, and Sno-Brite uncalcined clay. Unfortunately, these materials severely reduce elongation.

Correlations between pairs of tests were examined and found good enough so that some of the tests could be dropped in future screening work. General conclusion: fillers can increase range of utility of polyethylenes.

"Engineering the plastics 'House of the Future'," by ***A. G. H. Dietz***, *et al.* Modern Plastics *34*, Part I: p. 143 (June 1957); Part II: p. 119 (July 1957).

A plastics house of the future has been designed with an eye to convenience, beauty, and versatility of location. Made of a few large parts rather than many small ones, the design takes advantage of the almost unlimited formability and fabricability of plastics. The engineering analysis of the complexly curved structure is discussed in detail. Perhaps its most remarkable feature is that rigidity rather than strength dominated the design, resulting in a house with strength to spare. Because of the high coefficient of thermal expansion of the reinforced plastics material used (typical of plastics in general), stresses due to thermal expansion play an important role in the design. Weight-loading and thermal loading of full-size prototype test structures have shown the design to be sound in all its aspects.

The first half of this article discusses the architecture of the house, the loads it must bear, and materials consideration. The second half covers the design of the structure to withstand these loads, and the testing of the prototype.

"Sintered nylon," by ***L. L. Stott***, Modern Plastics *35*, 157 (Sept. 1957).

Nylon powders precipitated from solution can be pressed and sintered into many useful shapes. Because of the high crystallinity of the material as compared with the injection molded product, it has superior frictional and wearing qualities and higher compressive strength, though its tensile strength, elongation, and impact strength are lower than those of molded nylon. Various additives and fillers are easy to blend thoroughly with the fine nylon powders, making possible a wide range of compositions. Fillers such as molybdenum disulfide even enhance the wearing qualities while sharply reducing the dimensional sensitivity of the mixture to changes in temperature and humidity. The sintered nylons are thus excellently suited to frictional applications, particularly where reliable lubrication is difficult. Possible shapes, pressing and sintering techniques, and dimensional tolerances are discussed.

One of the designer's problems is choosing a resin for glass-reinforced products that must withstand weathering. The best available data have been reviewed and analyzed by ***L. Gilman*** in **"The resistance of glass fiber reinforced laminates to weathering,"** *SPE J. 13*, 33 (Nov. 1957). The results are brought up to date and the author's work culminates in a table giving his estimates of strength values after three years' exposure for three polyesters, one phenolic, one epoxy, and one silicone laminate; all the laminates contained about 63% glass. Values given are: tensile, compressive, and flexural strength, and wet flexural strength at room temperature and at 500° F. "It appears that an allowance of 20% will be generally safe for losses in mechanical properties during an outdoor exposure of three years, and that an allowance of 30% will be more than safe."

"Controlling the effects of moisture on molded nylon," by ***W. B. Happoldt, A. J. Cheney***, and ***E. M. Lacey***, *SPE J. 13*, 21 (March 1957).

Rates of absorption of moisture by type 6/6 nylon of various thicknesses are given, along with changes in dimensions associated with moisture pick-up. Since nylon parts are, on the average, exposed to humidity equivalent to 50% at 73° F., and since the equilibrium water content at these conditions is 2.5%, it is recom-


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mended that the design of critical nylon parts be based on the dimensions of molded nylon, annealed and conditioned to 2.5% water. Data on the effects of molding factors on annealing shrinkage, dimensional changes during annealing, and rates of water pickup during various conditioning procedures are given. With thin sections, moisture pickup from the atmosphere is often rapid enough to accomplish the necessary conditioning in a few hours or days.

"Selection and design of flurocarbon plastics," by ***M. W. Riley***, *Materials & Methods in D.E. 45*, 129 (June, 1957).

The outstanding properties of fluorocarbon resins are their excellent chemical resistance, high thermal stability, good electricals, and low adhesion and coefficients of frictions. This 20-page "design manual" lists types available, gives much data on properties of specific resins, discusses design of products with reference to processing, examines the use of these materials in many classes of applications (including coatings), with examples. A bibliography is included.

"Effect of lay-up configuration on flexural properties of 181 glass cloth laminates," by ***W. R. McGlone***, *SPE J. 13*, 30 (Oct. 1957).

"This paper discusses the effect of fiber location on the flexural properties of two different types of four-ply layups and also shows how the flexural strength and elastic modulus in bending vary with resin content. An estimate of the strength of the laminate based upon the strengths of the glass and resin and their orientation effects with increasing number of plies of cloth is shown." The theoretical calculations agree with measured moduli over the range from 3.5 to 5×10^6 p.s.i. within about 5 percent. Agreement with observed strengths was almost as good.

"Filament winding has a fine future," by ***G. Epstein*** and ***H. A. King***, Modern Plastics *34*, 132 (Mar. 1957).

Filament winding is a new process in which continuous glass roving, impregnated with a curable resin, is wound upon a form which corresponds in shape to the interior configuration of the fabricated part. The form is disposed of after the resin has been cured. Advantages: 1) windings can conform to complex curvatures—almost any conceivable shape can be made; 2) it is easy to do the winding so as to distribute strength in proportion to expected stress in various regions of the structure. Strength/weight ratio is higher than those of the best aluminum alloys, steels, and titanium metal.

Polyethylene, soon to be our biggest single plastic material, has some very valuable properties as an electrical insulating material. In **"Developments in polyethylene insulation,"** (*Elec. Mfg. 59*, 109, March, 1957), ***A. E. Javitz*** reviews the properties and limitations of various polyethylenes as electrical insulating materials. Molecular weight, molecular-weight distribution, branching, and cross-linking by irradiation can all be manipulated to produce a "rich variety in properties." Tables of pertinent properties are given, as well as a table of wire-coating compositions and wire-insulation standards. Coming: polypropylene and copolymers and vulcanizable compositions that will improve properties. Needed: oil and grease resistance at 80° C., flame resistance without property impairment, and improved corona resistance.

"I/EC review of materials of construction: plastics," by ***R. B. Seymour***, *Ind. Eng. Chem. 49*, 1629 (Sept. 1957).

This annual review of plastics as materials of constructions, while mainly pointed toward the chemical industry, is broad in coverage. Subheadings include the principal resins, pipe, foams, design information, structures, miscellaneous. The bibliography, exhaustive rather than selective, fills almost three pages.

The accredited engineering curricula of U. S. colleges and universities provide (and require) extensive instruction in the functional aspects of design but offer almost no instruction in the esthetic aspects. The gap in the engineer's training is filled by industrial designers, many of whom suffer from the reverse weakness. In this respect plastics engineers seem to be no better off than others. **"Product design in plastics,"** by ***A. H. Woodhull***, *Brit. Plastics 30*, 4 (Jan. 1957), is a lesson in the esthetics of plastics products design wherein the teacher keeps an eye on functional and processing requirements. Some gems: "The designer in plastics should never lose sight of the fact that at one stage in manufacture—the moulding operation—the material becomes viscous and flows . . . So many plastics articles on sale today are constipated little objects that do not reflect this characteristic . . . borrowing (ornamental detail) from past eras only stamps plastics as an imitation." Curved forms not only are fitting to plastics and look good, but often can be thinner in section with the same load-bearing ability, thereby saving material. Don't design a mold—design a product!

Casting

"Lessons in the molding of unsaturated polyesters as casting resins in elastic molds," by ***Dr. Schirmer***, *Plastverarbeiter 8*, 164 (May 1957). In Germany.

This article is mostly concerned with making elastic molds for casting polyesters. Such molds are divided into two main classes, thermoplastic and thermosetting, the former including Formalose (generic term not given), plasticized PVC, and gelatin, the latter including natural and silicone rubbers. Recipes for all five types are given.

Perhaps the best theoretical treatment of resin casting so far published is **"Control of chemical and physical factors in the application of casting resins,"** by ***P. L. Nichols***, *SPE J. 12*, 26 (Nov. 1956). The author first derives equations giving the adiabatic temperature rise and polymerization time in terms of order of reac-

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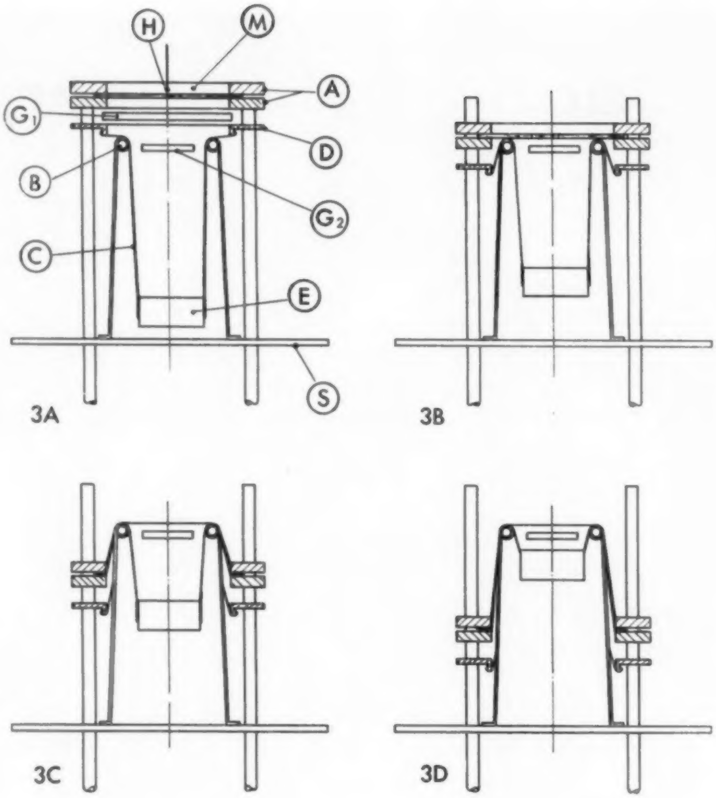
tion, monomer concentration, heat of polymerization, and heat capacity. Some suggestions for calculating shrinkage are offered. Equations giving temperature within a long cylindrical casting for zero-order and first-order polymerizations are presented and worked out (with the aid of a differential analyzer) for some representative sets of casting conditions.

Mechanical properties of cast resins are also treated. The author introduces a sliding-block element into the generalized Maxwell spring-and-dashpot model to help account for the effects of fillers, and achieves pretty fair agreement with observed stress/strain and stress/strain rate curves.

"Epoxy castings," by ***B. F. T. Langsdorf***, *Product Engineering 28*, 135-9 (June 1957).

Epoxy castings are considered as a lower-cost alternative to metal or molded plastics for limited quantities of complex parts. Properties of epoxy castings (in comparison with other casting resins), design considerations, tooling, mold release, curing temperatures and cycles, inserts, and finishing are covered.



Successive stages in testing elongation of formable sheet. 3A) Sheet *M* is heated; 3B) heater is withdrawn and stretching begins as clamping ring *A* and friction bag ring *D* move downward; 3C) stretching continues, with greatest elongation occurring in center section of sheet; 3D) flanges *A* and *D* have descended full preset distance and stretching is complete. Overstretched sheet will rupture inside ring

Sheet thermoforming

"Progress report on sheet forming," Modern Plastics *34*, 107 (May 1957), is an up-to-date review of the field. Recent developments in applications, materials, and machinery are all covered. A chart lists all the formable sheet materials available in the U. S. and includes names and addresses of makers, tradenames, base resins, methods of manufacture, as well as available thicknesses and widths.

"New test of sheet formability," Modern Plastics *35*, 145 (Nov. 1957).

The instrument and method described are capable of measuring the maximum areal elongation of any formable sheet at any temperature in its forming range, at a stretching rate typical of commercial forming. The resulting plot of areal elongation versus temperature will help plastics designers to judge the practicability of forming any particular piece, while sheet formers will be able to choose the most economical combination of operating conditions at which the elongation required for a given part can be accomplished.

Fibrous glass has not been very successful as a reinforcing agent for thermoplastic sheet, partly because of adhesion problems, partly because the glass, having high strength but almost no ductility, masked the ductility of the thermoplastics, so that glass-reinforced sheet was not formable. Reinforcement of acrylic sheet with Orlon, Dacron and nylon fibers, described in **"Synthetic fibers in formable sheet,"** by ***D. E. Jackson*** and ***D. A. Moore***, *Plastics Tech. 3*, 716 (Sept. 1957), overcomes both these difficulties. Orlon acrylic fiber increased the notched Izod impact strength of acrylic sheet without impairing its formability (at 25% or less fiber loading), while Dacron and nylon gave even greater increases in impact at some sacrifice in formability. Forming in matched metal molds was the most effective technique, vacuum methods not providing enough force. Craze resistance and tensile modulus were improved, tensile strength slightly reduced.

Machines for thermoplastics

If the plastics industry stopped growing tomorrow, i.e., if it continued to consume plastics at today's rates, most plastics producers and processors would go on doing a brisk business, but machinery makers would be hard hit.

In a fast growing industry like ours, even a slight slackening of the growth rate brings a drop in machinery sales, since replacement sales are probably less than 40% of the total. Apparently this has happened in 1957 (see "Markets for materials," p. 85 ff.), and the *numbers* of injection machines and extruders sold fell 14% and 9%, respectively, from last year's figures. Dollar-wise, however, the percentage drop in injection machine sales is less than 14% because most of the loss occurred in the smallest—and least expensive—size classes. Extrusion machine makers, over-all, might have grossed almost as much as last year (not counting price rises) because increased sales in the two smaller size classes and in the biggest class should come close to offsetting the big drop in 3.5-in. sales.

Sheet thermoforming is still mushrooming so fast that makers of forming machines outdid their last year's sales, nearly all of the increase being in the 6- to 12-sq. ft. class. However, the rise in sales in '57 was much less than that in '56; this, too, reflects the slower growth of the plastics industry in 1957.

Table I: Shipments of injection machines

Nominal shot capacity oz.	*Number of machines shipped* — *Domestic* 1954	1955	1956	1957	*Export* 1954	1955	1956	1957
2.5 or less	306	252	370	313	33	27	42	10
2.5+ to 7	262	351	355	290	25	11	28	22
7+ to 10	115	97	79	55	29	6	4	7
10+ to 18	208	241	286	286	16	11	2	7
18+ to 29	36	68	77	44	0	1	6	2
29+ to 35	15	6	2	15	2	2	1	2
35+ to 55	23	16	16	14	2	3	2	4
over 55	12	21	23	17	1	2	0	4
All sizes	977	1052	1208	1043	108	63	85	58

Table II: Shipments of extrusion machines

Screw diameter in.	*Number of machines shipped* — *Domestic* 1954	1955	1956	1957	*Export* 1954	1955	1956	1957
1.7 or less	81	106	102	115	20	21	21	21
1.7+ to 3.2	163	268	279	295	24	21	31	63
3.2+ to 4.2	199	207	268	151	18	12	40	49
4.2+ to 6.5	154 (4.2+ to 6.5 and over 6.5)	160	206	197	18 (4.2+ to 6.5 and over 6.5)	21	29	55
over 6.5		12	36	54		0	7	8
All sizes	597	753	891	812	80	75	128	196

Table III: Shipments of sheet thermoforming machines

Heater area sq. ft.	*Number of machines shipped* — *Domestic* 1955	1956	1957	*Export* 1955	1956	1957
3 or less	36	180	149	—	4	15
3+ to 6	80	96	72	—	5	4
6+ to 12	92	52	137	—	3	7
12+ to 18	56	20	30	—	3	1
18+ to 30	30	46	40	—	4	5
over 30	13	1	2	—	0	1
All sizes	307	395	430	0	19	33

Table IV: Ten-year resume of processing machinery deliveries in the U. S.

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Injection molding machines										
Number delivered in year	478	712	869	568	764	1189	977	1052	1208	1043
Year-end cumulative total	4102	4814	5683	6251	7015	8204	9181	10,233	11,441	12,484
Screw extruders										
Number delivered in year	115	346	320	485	487	549	597	753	891	812
Year-end cumulative total	1641	1987	2307	2792	3279	3828	4425	5178	6069	6881
Sheet thermoforming machines										
Number delivered in year	—	—	—	—	—	—	—	307	395	430
Year-end cumulative total	—	—	—	—	—	—	500	807	1202	1632

National technical conference of the S.P.E.

Program and abstracts of papers to be presented at the 14th annual meeting

The Hotel Sheraton Cadillac in Detroit will be the site of the 14th annual technical conference of the Society of Plastics Engineers, to be held January 28-31, 1958. Its theme: "Progress through plastics engineering." Conferees may register on Monday, from 2 p.m. to 9 p.m. There will be two luncheons—a business luncheon on Tuesday and a general luncheon on Wednesday. On Thursday evening there will be a cocktail party and president's reception and a banquet, at which Dr. Henry Pildner of the Industrial Div., Atomic Energy Commission will speak.

The technical sessions are organized as in recent years, with three or four running concurrently each morning and each afternoon. Times and subjects are listed below:

Tuesday morning: Radiation and Plastics—I.

Tuesday afternoon: Radiation and Plastics—II, Epoxy Resins and Embedment, Extrusion—I, Injection Molding—I.

Tuesday evening: Educational Symposium.

Wednesday morning: Packaging, Plastic Tooling, Mold Design, New Materials—I.

Wednesday afternoon: Test Methods, Injection Molding—II, Reinforced Plastics, Extrusion—II.

Thursday morning: New Materials—II, Automotive Applications, Color and Finishing, Mold Design—II.

Thursday afternoon: Potpourri, Extrusion—III, Injection Molding —III, Foams.

Friday morning: Compression Molding, Sheet Forming, New Materials—III, Rheology.

The abstracts presented below, in the order listed in the Advance Program, have been adapted from those submitted by the authors.

Tuesday morning

SESSION I: RADIATION AND PLASTICS—I; *Moderator, W. E. Gloor.*

Radioisotopes and Plastics, *by P. C. Aebersold.* The technical and economic fundamentals of radioisotope applications will be discussed. Speculation as to the potential effect on the plastics industry will be included.

Accomplishments in Plastics Applications with Radiation—United States and Abroad, *by J. R. Stirrat, A. Miller, and E. Lawton.* Commercial and near-commercial accomplishments in the United States and abroad will be described. Basic chemical reactions and resultant changes in physical properties involved in these processes will be outlined.

The Role of Atomic Radiation in Plastics Science and Technology, *by R. F. Boyer and R. McFedries.* Polymerization, cross-linking, grafting, and degradation as applied to the fabrication field will be discussed. Several schemes for adaptation to high-volume production will be mentioned.

Tuesday afternoon

SESSION I: RADIATION AND PLASTICS—II; *Moderator, R. F. Boyer.*

Ionizing Radiation, *by A. J. Gale.* The various forms of radiation will be outlined. The advantages and disadvantages of each type will be presented from a technical and economic point of view.

Operation of a Radiation Facility, *by J. W. Ranftl.* A typical production facility will be described. Emphasis will be placed on shielding, instrumentation, control of atmosphere, safety devices, etc. An analysis of operating expenses will be included.

Practical Problems in Radiation Curing, *by R. G. Bauman.* Vulcanization or curing of molded rubber goods through the use of nuclear radiation eliminates all vulcanizing agents, accelerators, retarders, and heat. It provides finished rubber goods with aging properties superior to conventional cures. A conventional 7.60-15 passenger car tire was successfully vulcanized using gamma radiation from twenty fuel elements from the Arco, Idaho, Materials Testing Reactor.

Graft Copolymerization on Polyethylene, *by H. G. Hammon.* The necessary equipment may be readily installed by most plastic fabricators. The basic technique of grafting with high-energy radiation is discussed, including the variables involved in both pre-irradiation and mutual irradiation methods.

SESSION II: EPOXY RESINS AND EMBEDMENT; *Moderator, C. A. Harper.*

Characteristics of Flexible Epoxy Resins, *by H. C. Klassen.* Several ways of obtaining flexible epoxy resins, and comparison of their physical and electrical prop-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erties when cured with anhydrides, flexibilizing amines, and modified acid catalysts will be discussed.

Strain Gage Evaluation of Casting Resins, *by R. N. Sampson.* Description of apparatus and results from studies made on internal stresses of variables such as resin type, filler type and concentration, curing cycle, temperature conditioning, etc., using an embedded strain gage technique.

Materials Handling of Epoxy and Polyester Resins, *by W. A. Gammel, Sr.* The principal systems used for handling, mixing, and dispersing embedment-type materials, and economic comparisons for various production levels.

Heat Resistant Epoxy Resin Systems, *by J. E. Carey and F. C. Hopper.* A discussion of the strength and aging properties of a new, highly functional epoxy resin is presented. In laminates reinforced with 181 glass fabric, it retains 40,000 p.s.i. flexural strength at 500° F. after 200 hours at this temperature. Its properties are compared to those of well-known commercial epoxy resins cured with several curing agents.

SESSION III: EXTRUSION—I; *Moderator, A. A. Kaufman.*

Extrusion Theory, *by L. F. Street, H. M. Hulbert, and S. Katz.* This will be an analysis of the path followed by the particles of plastic material flowing in the channels of an extruder worm.

Beta Gage Measurement and Control of Plastic Thickness and Area Weight, *by G. L. Doering.* The increasing use of thin plastic film has emphasized the need for a more accurate measurement of weight per unit area. The extrusion—lamination process presents some unique measurement problems. The measurement requirements for blown bi-oriented films differ from those of the sheet die process. This talk discusses the application of nucleonic equipment on the different extrusion processes. Accuracy of ±0.005 *mils* is possible.

Estimating the Drag-Flow Efficiency of Extruder Screws, *by P. H. Squires.* An easy-to-use method for exactly estimating the drag-flow conveying capacity of an extruder screw will be presented.

Power and Heat Energy Relations in Polyethylene Extrusion, *by B. H. Maddock.* A simplified analysis of the polyethylene extrusion process will be presented from the standpoint of power requirements and heat development.

SESSION IV: INJECTION MOLDING—I; *Moderator,* W. J. *Gobeille.*

Injection Molding of Large Sections, *by M. Silovich.* Sheet thermoforming has made heavy inroads on the injection molding of large-area parts (1500 sq. in. and over). The development of multigating methods now enables injection molders with big machines to recapture this lost business. Advantages and tooling factors are analyzed.

Conical Heat Chamber, *by R. T. Wheeler.* A conical heating chamber, designed for rigid PVC, has also been successful with other resins. Ram pressures could be reduced about 40%, cycle time 30 percent.

Preplastification for Injection Moulding, *by E. Gaspar and M. G. Munns.* The advantages which result from the principle of preplasticating are outlined and the various practical methods of employing this principle on modern machines are also mentioned. These include both screw-type and plunger-type preplasticators which have been developed in the U.S.A. and Europe.

Forming of Aerosol Containers of "Zytel" Nylon Resin, *by J. B. Patton, R. M. Bonner, and W. E. Ebeling.* Process will be described for the molding of "Zytel" into aerosol containers.

Tuesday evening

SESSION I: EDUCATIONAL SYMPOSIUM; *Moderator, R. C. Bartlett.* (Speakers names and abstracts of talks not yet available.)

Wednesday morning

SESSION I: PACKAGING; *Moderator, M. J. deVietien.*

The Properties of Linear Polyethylene Pertinent to the Packaging Industry, *by L. F. Swec.* When polyethylene having an initial density of 0.96 is extruded through a flat die at high temperatures and properly quenched, some of the properties required most of a packaging film are enhanced. By thus controlling the crystallinity of the film, substantial improvement can be noted in impact strength and clarity.

Health Safety of Plastics in Food Packaging and Housewares, *by D. D. McCollister and W. J. Sauber.* Considerations pertinent to evaluating safety for the consumer will be discussed from the viewpoint of the manufacturer, fabricator, and government agencies.

End-Use Correlation of Styrene Container Testing, *by B. Nathanson.* New test methods developed for end-use correlation which allow definite grading by numbers rather than empirical judgment will be described.

Oriented Polystyrene Film, *by F. C. Dulmage.* A resume of the development of oriented polystyrene film will be given. The present acceptance and strong potential of the material will be pointed out.

SESSION II: PLASTIC TOOLING; *Moderator, F. Lyijynen.*

Plastics as Used for Tooling Aids in the Stamping Industry, *by E. Ruddiman.* The various phases of plastic tooling in the stamping field will be discussed. Fixtures, models, dies, etc. will be described.

Plastic Tooling in the Aircraft Industry, *by R. H. Voss.* The successful use of plastics in the aircraft industry in drop hammer dies, gages, routers, forming

dies, checking fixtures, etc. will be covered.

Plastics in Foundry Practice, *by W. R. Weaver.* Applications of plastics in the foundry industry will be discussed. The resultant reduction in cost and mold preparation time will be emphasized.

Plastic in the Metal Working Industry, *by G. M. Rice.* The outstanding advantage of plastics is that they can be cast or molded with inexpensive tools, and with a minimum of time and labor to close dimensional tolerances with little or no machining or spotting. Reinforced plastics have made possible the development of new tools for the automotive, aircraft, appliance, and entire tooling industry. Such plastic tools expedite and coordinate the total tooling programs and reduce over-all costs. The use of plastic tools has resulted in greatly reduced weight compared with conventional types and has simplified general tooling operations.

SESSION III: MOLD DESIGN; *Moderator, L. J. Morrison.*

Machining Practices in Mold Making, *by E. J. Krabacher and P. A. Ropp.* The latest tracing techniques for die sinking will be demonstrated and discussed.

Reducing Mold Costs and Improving Quality Through Planning Methods, *by W. D. Evans.* This paper relates primarily to *how* molds are built. Improvement in quality by technical methods of precision, by reducing opportunities for errors through processing methods, and by providing a system of measuring dimensions for the machine operator to cut and for checking his work.

The Theory and Study of Latest Techniques of Mold Design for Linear Polymers and Other Thermoplastic Materials, *by A. Spaak.* The latest designs which are now being introduced for molds to handle linear polymers will be discussed.

Mold Polishing, *by A. W. Logozzo.* Scale removal, stoning, polishing and final coloring with equipment and methods will be discussed and supplemented by motion pictures.

SESSION IV: NEW MATERIALS—I; *Moderator, E. L. Kropscott.*

Practical Methods of Fabricating High-density Polyethylene Sheets, Rods, and Tubes, *by E. Rottner (to be read by W. P. Acton).* With high density polyethylene, hot-air welding often results in weld strengths only 30% of the original material. This paper describes "butt-welding," in which two sheets of high-density polyethylene are joined by softening the edges of each sheet against a hot plate heated to 200° C., then pressing the sheets together causing the material to fuse along the seam. The joints are as strong as the base material.

Molding Characteristics of Diallyl Phthalate Compounds, *by L. B. Keller, W. R. McGlone, and D. H. Woodin.* A review of compression and transfer molding of diallyl phthalate materials for critical missile electrical parts.

Lexan Polycarbonate Resin—A New High Strength, Heat Resistant Plastic, *by W. F. Christopher.* The properties and technical aspects in fabrication of polycarbonate resins.

Application of Larson-Miller Correlation to Service Test Data on High-Density Polyethylene, *by W. E. Gloor.* Short-time, high temperature tests on polyethylene pipe of 0.945 density have, using the Larson-Miller correlation, given useful predictions of service life under load at lower temperatures. Permissible hoop stress at 75° F. for long-time service is 670 p.s.i.

Wednesday afternoon

SESSION I: TEST METHODS; *Moderator, F. W. Reinhart.*

Measuring Gas Transmission Performance of Plastic Films, *by W. E. Brown and W. J. Sauber.* A new instrument will be described for automatically measuring gas permeability with speed and accuracy.

Friction and Abrasion Characteristics of Plastic Materials, *by M. Marcucci.* Apparatus for evaluating friction and abrasion. Results for plastics contacting metals at three rates of speed will be reported.

Applications of the Tensile Impact Test, *by R. H. Carey and M. S. Nutkis.* Tensile impact results correlate with melt index and density of polyethylene and show temperature transition regions in which toughness changes greatly.

Evaluating Plastics for Compression Molding Phonograph Records by Use of a Capillary Extrusion Rheometer, *by W. E. Coleman.* Changes in viscosity of molten plastics as a function of shear rate and stress will be shown to determine moldability.

SESSION II: INJECTION MOLDING—II; *Moderator, M. G. Sherwood.*

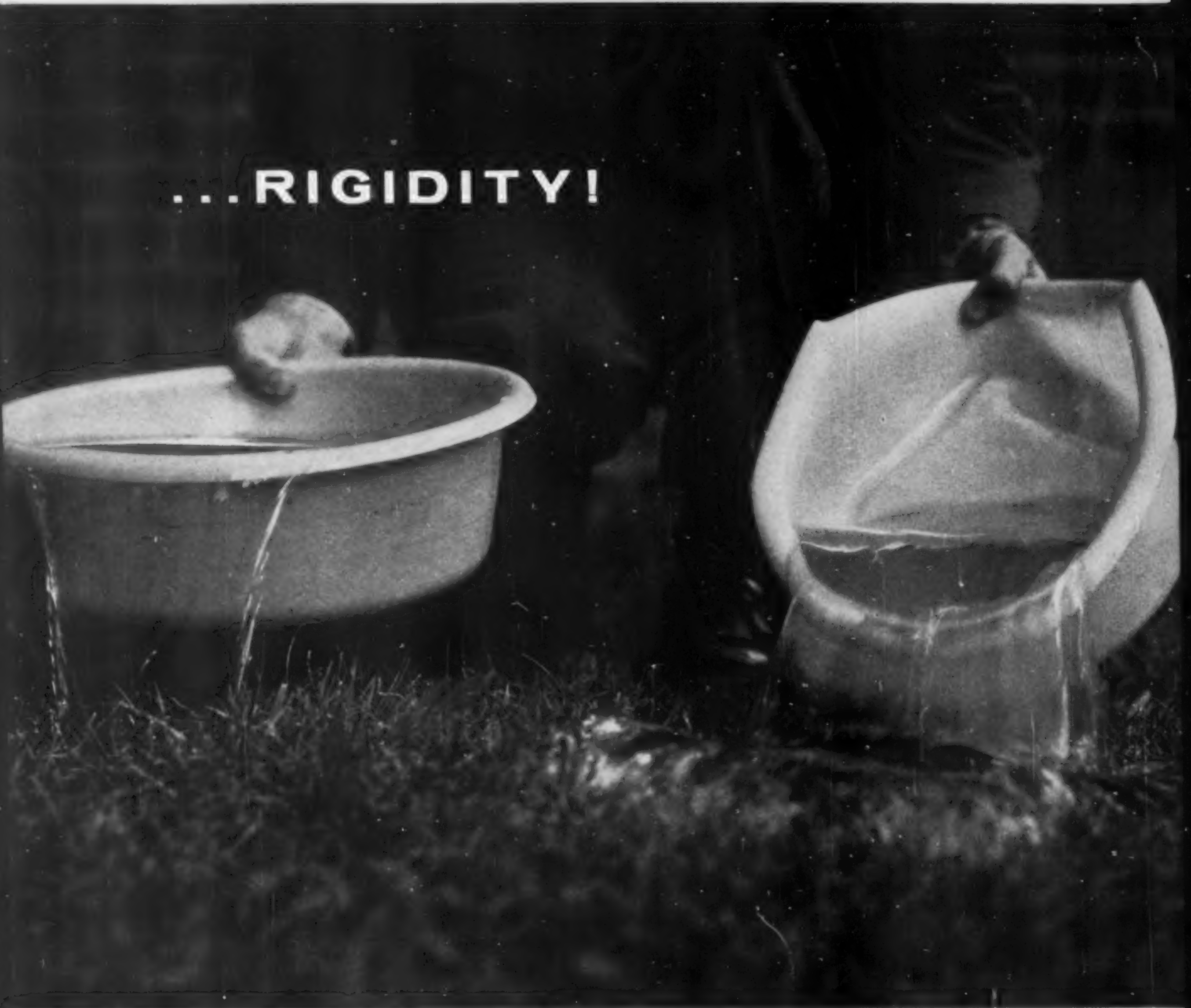
Effect of Processing Conditions Upon Density of Linear Polyethylene, *by J. P. Fogerty and E. Poindexter.* This paper will describe the effect on density of variation in pressure, time, temperature, cooling temperature, and cycle on injection and compression molding of linear polyethylene.

New Techniques in Injection Molding of Linear-Type Polyethylene, *by D. A. Jones.* This paper will cover techniques of molding of a material new to most molders, which is now making its appearance on the market in volume.

Better Operation with Better Plant Layout, *by R. L. Beesley and D. B. Semeyn.* A study of plastics manufacturing, plant layout, and its relationship to material handling, better methods, ease of maintenance, plant appearance, safety, and future plant expansion.

Molded Shrinkage and Dimensional Stability of Nylon 6, *by J. M. Verdi and R. F. Flaherty.* Shrinkage of nylon 6 can be var-

(*To page* 150)



Test dishpans made from the same mold using conventional polyethylene and Fortiflex demonstrate the superior rigidity possessed by Fortiflex. The dishpans were placed on the ground, then filled with equal amounts of water. The tester attempted to lift each with one hand. The Fortiflex molded dishpan had the needed rigidity. The conventional polyethylene dishpan collapsed under the weight.

FORTIFLEX

Polymer chemistry produces another wonder

...a high-density linear polyolefin plastic

Laboratory test shows the effect of sterilization on standard molded nursing bottles made of conventional polyethylene, Fortiflex and glass. Only the glass bottle and Fortiflex bottle withstood the 15-minute test conducted at 15 psi, 250° F.

A polyethylene that withstands sterilization . . . that has outstanding rigidity and excellent surface gloss . . .

These are the distinguishing characteristics of Celanese Fortiflex—the chief reasons why this new plastic is moving into areas of usefulness never before practical or even possible.

Linear in structure, with resulting high density, Fortiflex possesses the rigidity, heat resistance, strength and high lustrous surface so vital to the development and production of a wide variety of consumer and industrial products. Appliance and equipment housings and parts; containers, caps, and closures; housewares; toys; monofilaments for ropes and textiles, are good examples.

Its other important properties—low permeability to moisture and most gases, and excellent electrical and chemical characteristics—make possible applications such as electrical insulation, rigid lightweight pipes for the transmission of fluids and gases, packaging films.

There's scarcely an industry that won't benefit from the development of Celanese Fortiflex. This new plastic, now in commercial production, is being shipped in volume from warehouses located in Newark, N. J.—Chicago, Ill.—Los Angeles, Calif.—and from the Celanese Fortiflex plant in Houston, Texas.

OTHER CELANESE PRODUCTS AND SERVICES

As an industry pioneer, as the producer of Cellulose Acetate and Propionate (Forticel) molding compounds, PVAc and Polyester resins, Acetate Films and Sheeting, and Triacetate Films, Celanese has contributed to many improvements in basic production materials and their applications.

Celanese maintains a Technical Service and Applications Laboratory to provide assistance in your work with synthetics. Personal assistance from a Celanese Technical Representative, as well as technical data, are also available to you in the application of the wide range of Celanese materials to your products and processes.

Celanese® Fortiflex® Forticel®

Celanese PLASTICS and RESINS

Celanese Corporation of America, Plastics Division, Dept. 101-A
290 Ferry Street, Newark 5, N. J.

Canadian Affiliate:
Canadian Chemical Co., Limited, Montreal, Toronto, Vancouver

Export Sales:
Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Ave., N. Y. 16.

ied over fairly wide limits by varying molding conditions. Annealing will tend to minimize differences in mold shrinkage as a result of variations in molding conditions. Crystallization, which is dependent upon cooling rate, is an important factor affecting shrinkage. Control of mold temperature is an important tool for controlling the crystallization and shrinkage of thin section moldings. Fluctuations in humidity and temperature also cause dimensional changes. Proper procedures for estimating cavity sizes for precision parts are recommended.

SESSION III: REINFORCED PLASTICS; *Moderator, M. J. Petretti.*

Effects of Elevated Temperature and Erosion on Reinforced Plastic Laminates, *by N. B. Miller and E. L. Strauss.* Test specimens were exposed to the afterburner blast of an Allison J-71 jet engine which produced temperatures of approximately 3000° F. and gas velocities in the neighborhood of 2500 ft./second. The exposure time for the specimens ranged from 12 to 60 seconds. The materials investigated included glass-phenolic, glass-silicone, glass-polyester and asbestos-phenolic laminates. The physical appearance, weight loss, and retained strength of the exposted test samples were selected as the factors which determine the ability of the laminates to withstand the test environment.

Development of Steam Resistant Fiberglass Reinforced Plastics, *by E. G. Bobalek, W. Ellslager and T. Harris.* Autoclave-able utensils of excellent finish can be compression molded from reinforced polyesters if 1) the resin is hydrolysis resistant, 2) all components of molding compound are kept bone-dry before molding, 3) surface is finished with Dacron overlay or epoxy gel-coat, 4) care is taken in molding. Such utensils can compete with injection molded, steam-resistant thermoplastics.

Fabrication of Reinforced Plastics Made From Acrylic Sirup, *by B. Mead, Jr., J. A. Ross and J. T. Rundquist.* An acrylic sirup can be used to make such glass-reinforced products as corrugated sheet, flat decorative and structural sheet, furniture, and other complex shapes. These products have excellent resistance to weathering. Most of the equipment now used by the industry for fabricating polyester resins can be used with acrylic sirup, but certain important modifications are necessary. The effect of process variables on quality and typical measurement and control methods are discussed.

A Discussion of Polyester Premix, *by W. O. Erickson.* The fundamentals of polyester premix compounding, mixing, and molding with special emphasis on the fibrous reinforcement ingredients.

SESSION IV: EXTRUSION—II; *Moderator, W. E. Jacobson.*

Effect of Extrusion Conditions on Strength and Appearance of Polyethylene Pipe, *by J. F. Morris.* The effects on bursting strength of pipe of draw rate, stock temperature, screw cooling, and reworking were explored, with these main conclusions: draw rates of 25 to 30% had no effect, reworking had no effect, stock temperature affected only the appearance when it fell below 290° F. Screw cooling affected burst strength but cut output.

Rigid Polyethylene Pipe, *by L. B. Croley and R. Doyle.* Description of suitable extrusion techniques for rigid polyethylene pipe of Marlex 50 and test data on certain standard sizes.

Polyethylene Monofilaments, *by J. F. Groel and J. H. Versteeg.* The paper reviews some of the important physical properties of polyethylene resins and compounds which make this material particularly desirable for many high-quality monofilament applications; highlights the established and potential markets for these filaments; and details the extrusion equipment and techniques employed in the fabrication of polyethylene monofilaments.

Extrusion and Vacuum Forming of High Density Polyethylene Sheet, *by J. G. Farrow and G. H. Sollenberger.* Extrusion of higher density polyethylene sheet can be accomplished with equipment which is normally used for impact polystyrene with some modifications in the operation of the polish rolls and takeaway. Likewise, commercial sheet thermoforming equipment has been found to be fully adequate if procedures are modified to allow for the higher heat resistance of this material.

Thursday morning

SESSION I: NEW MATERIALS —II; *Moderator, J. A. Clark*

Properties of High Temperature Epoxy Systems, *by L. S. Buchoff and W. R. Sherwin.* Weight loss determinations will be discussed, using epoxy resin with various hardeners over a wide range of temperatures and water content.

European Progress in Plastics, *by Z. Merszei.* A discussion of significant developments in both new materials and equipment as related to Western Europe will be presented.

Properties and Applications of New Low-Viscosity, Solventless, Thermosetting Silicone Resins, *by M. E. Nelson.* These resins were designed to form void-free encapsulations and impregnations for electric or electronic equipment. Full curing is obtained with peroxide catalyst and a step cure of nine hours at temperatures up to 390° F. Cured, they exhibit excellent dielectric properties, moisture resistance, thermal conductivity, and mechanical strength despite prolonged exposure to 400° F. or intermittent service at as high as 500° F. Field applications include aircraft transformers, motors and electronic assemblies.

Delrin Acetal Resin—A New Thermoplastic. Properties, Fabrication and End-Use Testing, *by R. J. Manning, R. H. Hardesty, and J. F. Cogdell.* Stiff, strong, creep- and fatigue-resistant, this stable polymer of formaldehyde

retains good properties at high temperatures and humidities, and in the presence of nearly all organic liquids. It is readily processed in standard equipment.

Pearl PVC: A New Vinyl Chloride Resin, *by R. S. Holdsworth, W. Mayo Smith, and J. T. Barr.* Pearl PVC is characterized by exceptionally large particles which are uniform, porous, and completely dust free. The plasticizer absorption of the PVC pearl polymer is excellent and the resulting dry blends have good flow properties. A series of high, medium, and low molecular weight PVC pearl resins were prepared. The processing and physical properties, color, and clarity are good and insulation resistance is acceptable and ages well.

SESSION II: AUTOMOTIVE APPLICATIONS; *Moderator, J. T. O'Reilly.*

General Review of Automotive Applications for Plastics, *by E. J. Storfer.* General outline of present applications with emphasis on recent developments not covered at the same session.

Reinforced Plastics in the Automobile, *by J. G. Coffin.* Review of latest structural body applications particularly, but including plastics reinforced with low cost fibers for trim and accessory applications.

Polyurethane Foam in the Automotive Industry, *by M. J. Sanger.* Recent applications with emphasis on seat topper pads and cushions and realistic corresponding performance tests. An extensive accumulation of test data indicates that polyether-urethane foam can be expected to withstand deteriorating influences.

Plastics in Automotive Trim, *by R. McCullough.* A review of present practice emphasizing latest material and processing for door and side panel trim.

SESSION III: COLOR AND FINISHING; *Moderator, C. F. Massopust.*

Coloring by the Molder, *by J. E. Simpson.* A paper on obtaining the most intimate mix of colorant particles and basic methods of coloring thermoset and thermoplastic materials.

Recent Developments on Finishes and Application Techniques for Vacuum Metallizing Plastics, *by M. A. Self.* Types of finishes available for vacuum metallizing, physical properties and limitations, handling and application characteristics, and test data on transparent pigments will be discussed.

Hot Leaf Stamping, *by M. A. Olsen.* A heat and pressure transfer method of dry opaque marking on all materials except glass and metal will be described.

Coloring Methods for Marlex 50 Polyethylene, *by J. N. Scott and J. V. Smith.* The efficiency of nozzle dispersion plugs, and the effectiveness of dry blending powdered pigments and pigment concentrates will be discussed.

SESSION IV: MOLD DESIGN—II; *Moderator, E. C. Fries.*

Mold Cost as Affected by New Metal Casting Methods, *by J. A. Kavanagh.* This paper will describe a new casting process used to attain cavities and cores and the effect on mold costs.

Practical Design for Hot Runner Molding, *by J. R. Grenier.* This paper will describe the theories and construction principles of hot runner molds now in actual production for molding polyethylene, polystyrene, butyrate, and vinyls.

The Use of Heat Resistant Epoxy Formulation for Producing Low Cost Molds for the Plastics Industry, *by R. T. O'Connor.* This paper will cover the design and fabrication of low cost molds and components for short runs with specific details for injection molding, compression molding, and vacuum forming.

Tooling Cavities for Quality Class Commercial II Molded Plastic Gears, *by J. R. Venne.* This paper discusses a simplified engineering method for obtaining dimensions for a gear cavity which will produce close-tolerance molded plastic gears. Methods selected for fabricating gear cavities, and a tooling analysis for the selection, are described.

Thursday afternoon

SESSION I: POTPOURRI; *Moderator, A. A. Pavlic.*

Publicity is NOT "Free," *by L. R. Greif.* After distinguishing between useful publicity and puffs, Mr. Greif will outline some proved methods of writing and illustrating press releases and feature articles. His suggestions for getting along with editors: "Be honest, on time, useful, and thoughtful." Estimates of the costs of some publicity campaigns.

Printed Wiring Processing, *by E. B. Murphy.* A movie and discussion of a method for producing printed wire circuits with emphasis on polymer requirements for the process.

Methods for Joining Plastic Parts, *by A. J. Cheney and W. E. Ebeling.* Four methods of assembling plastics components are discussed; they are: riveting with chemically expanded rivets, press fitting, induction welding, and friction welding.

Plastic Research and Development: Fact or Fancy from a Manager's Viewpoint, *by R. M. Houghton.* A technique for project evaluation and establishing project control as first steps in product planning will be discussed.

SESSION II: EXTRUSION—III; *Moderator, C. N. Sprankle.*

The Extrusion of Polyethylene Film with Controlled Properties by the Flat Film Process, *by H. B. Robinson, Jr., and W. A. Haine.* Some of the extrusion variables, and their effects and inter-relationship, from the standpoint of producing flat polyethylene film with controlled properties will be discussed.

Polyvinyl Dry Blend Extrusion in the Wire Coating Field, *by E.H. Hankey and R. D. Sackett.* Data

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Plastics Technical Section

Dr. Gordon M. Kline, Technical Editor

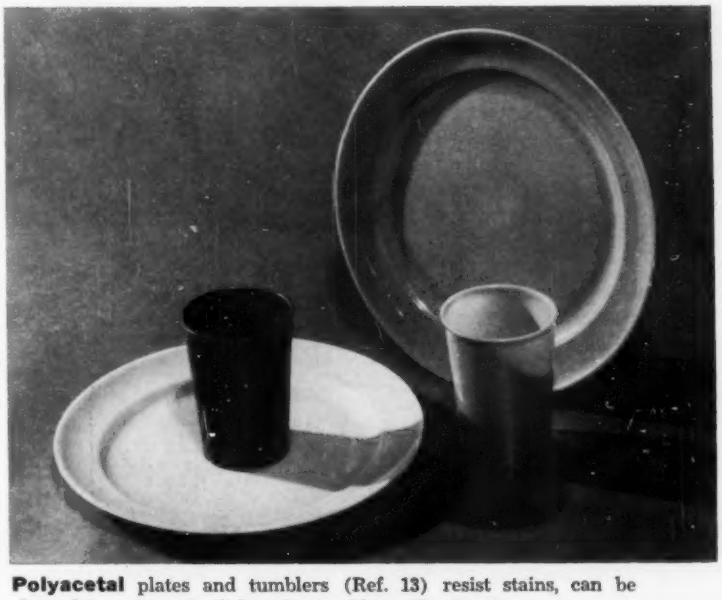
The year 1957 in review

The growing importance of world trade in plastics was spotlighted in a comprehensive analysis containing statistics of importance to materials manufacturers, processors, and consumers (1).[1] Between 1929 and 1956 this export trade increased from 35 million lb. to about 1.2 billion lb., approaching 20% of the total world production. Although the United States produces about 60% of the world's total of plastics raw materials, it exports only about 10% of its production; however, this percentage is sufficient to make it poundwise the largest exporter of plastics in the world, namely, about 390 million lb. in 1956. West Germany, Great Britain, and Italy are the next leading exporters of plastics; these countries export 25 to 50% of their national production of plastics. The European market is declining in relative importance for the United States, as South America, Canada, and the Far East receive increasing proportions of American exports. Cross-licensing of patents and the establishment of subsidiary plants abroad have become a very significant part of world trade in recent years. In 1956 American companies established plant operations in such diverse locations as Japan, Mexico, Brazil, Australia, and India. The importance of international standardization of test methods, specifications, and terminologies for plastics and the desirability of continued active support of the work of the International Standardization Organization's Technical Committee on Plastics (ISO/TC 61) is obvious from this survey of world commerce in plastics (2, 3).

A noteworthy review of the history and current status of our knowledge of high polymers and their properties was published in a series of articles in an issue of *Scientific American* devoted to giant molecules (4-12). Active frontiers now being explored include the production of "superhigh polymers" with molecular weights in the millions and an increase in the resistance of polymers to heat. The prospect for making high polymers that will be able to withstand substantially higher temperatures than the present limit of 600° F. is regarded as promising; they may be based on highly stable organic molecules such as diphenyl oxide or diphenylmethylene, with additions of resistant elements such as fluorine, boron, or silicon.

New resins

Polyformaldehyde: A new acetal-type resin (Delrin, E. I. du Pont de Nemours & Co., Inc.) became available in limited supply for evaluation programs (13). This resin has the structural unit -CH_2O- and is made by the polymerization of formaldehyde. It is a high-melting, highly crystalline, thermoplastic polymer suit-



Polyacetal plates and tumblers (Ref. 13) resist stains, can be cleaned in automatic dishwashers. (Photo, Du Pont)

* Reg. U. S. Pat. Off.
[1] Numbers in parentheses link to references at end of article, p. 170.

Valve made of chlorinated polyether (Ref. 16) has not been affected by flashback of hot HCl in chlorination reaction line

able for engineering applications where a material must retain toughness and dimensional stability under conditions of high temperature and humidity over an extended period under stress or on exposure to most solvents. The polyformaldehyde has a heat distortion point of 212° F. under a load of 264 p.s.i. and 340° F. at 66 p.s.i. Its water absorption at room temperature is 0.4% in 24 hr. and 0.9% at equilibrium; specific gravity 1.425; flammability 1.1 in./min.; crystalline melting point 347° F.; flow temperature 363° F. It has been field-tested for periods up to two years in such applications as connecting-rod sleeve bearings, movie projector gears, tableware, football shoe cleats, actuator cams on electric typewriters, shower heads, water sprinkler gears, butt hinge bushings, cart wheels, generator bearings, and aerosol containers. It has been announced that a large-scale plant for the manufacture of Delrin will be constructed near Parkersburg, W. Va., and that shipments from the new plant are expected to begin by mid-1959.

Polycarbonates: A new group of thermoplastic resins based on the reaction of 4,4-dihydroxy-diphenyl-alkanes with phosgene was announced in Germany in 1956 (14). A concurrent development in this country has resulted in the availability of pilot plant quantities of a polycarbonate resin (Lexan, General Electric Co.) made from bisphenol-A by reaction with phosgene or by an ester interchange (15). The repeating structural unit is

$$-C_6H_4-C(CH_3)_2-C_6H_4-O-\overset{\overset{\displaystyle O}{\|}}{C}-O-$$

The heat distortion temperature is about 290° F. under loads of 66 or 264 p.s.i.; specific gravity is 1.2; 24-hr. water absorption is 0.3%; crystalline melting point is 514° F. The most outstanding single property of this resin is very high impact strength, 15 to 20 ft.-lb./in. of notch by the Izod test. In tensile-impact strength the polycarbonate resin is 2 to 3 times stronger than nylon, equivalent to Teflon, stronger than aluminum, and about one-half as strong as oriented polyester-glass rod. The resin is also characterized by outstanding thermal and oxidative stability; it will withstand 570° F. for 24 hr. in an inert atmosphere and 300° F. for three months in air. Repeated heat cycling from —100 to 285° F., as well as boiling water treatment for several weeks produces no deformation or change in dimensions. The material offers promise in such applications as coil forms, electronic components, gears, auto lenses, batteries, and decorative and functional appliance parts.

Chlorinated polyether: Detailed information was published on the properties of a new polymer made from chlorinated pentaerythritol. The repeating structural unit is $-CH_2C(CH_2Cl)_2CH_2O-$. Its heat distortion point is 185° F. at 264 p.s.i and 300° F. at 66 p.s.i.; specific gravity is 1.4; water absorption is negligible. Low melt viscosity, low volume change in proceeding from melt to solid, and rapid crystallization at mold temperatures of 190 to 200° F. permit ready molding into strain-free, close-tolerance, dimensionally stable forms. Its potential market is in applications requiring a chemical-resistant plastic with better fabricating properties than the fluorocarbons and with greater heat resistance than the vinyl and vinylidene chlorides (16, 17).

Polyethylene oxide: Ethylene oxide can be polymerized to a high-molecular-weight, tough, crystalline polymer by the use of an anionic catalyst, calcium carbonate of controlled purity, water content, and possibly crystalline form. The structural unit is $-CH_2CH_2O-$. Polymers with molecular weights up to 3 million and intrinsic viscosities up to 20 exhibit some unique solution properties. They are nonionic and miscable with water in all proportions; they offer unusually high thickening power in comparison with familiar water-soluble polymers. They yield tough, flexible films on drying that have an unusually high degree of crystallinity with the result that physical properties are substantially unaffected by relative humidities up to about 90 percent. Brittle temperature is near —60° F.; crystalline melting point is 150° F.; extensibility at break is about 700%; modulus of elasticity is about 50,000 p.s.i. Cold drawing gives a highly oriented material with a five-fold increase in tensile strength (18, 19).

It will be noted that all of these new polymers involve chains in which carbon-oxygen bonds are present. Other related developments are under way. For example, it has been reported that acetaldehyde can also be polymerized to a high polymer; an isotactic polymer is obtained at —40 to —60° F. Precisely controlled small amounts of water are a factor in obtaining high polymers with the aldehydes. Another such group of polymers with carbon-oxygen linkages in the chain is the polyanhydride type. It has been found that polyterephthalate can be produced by condensation of terephthalic acid in the pres-

ence of acetic anhydride. The polymer is highly crystalline and stable (20).

Polyolefins: The preparation of fibers, plastics, and elastomers from stereoisomeric polymers produced by stereospecific catalysis was reviewed (21). The new polymerization process has made possible the production of linear, highly crystalline polymers, with high melting points (m.p.). The completely linear polyethylene has a melting point of 280° F. Isotactic polyolefins made from poly-3-methyl-1-butene and poly-3,3-dimethyl-1-butene have melting points higher than 482° F. From the practical point of view the most interesting polymers are isotactic polypropylene (m.p. 347° F.) and poly-1-butene (m.p. 277 to 284° F.) because of the low cost of the monomers and their ready availability by the cracking of petroleum.

New stereoblock polymers of high molecular weight are of interest, owing to the control of crystallinity and hence of elasticity compared with that of the highly crystalline polymers. These stereoblock polymers consist of macromolecules containing isotactic chain sections interspersed with atactic sections or with isotactic sections of opposite steric configurations. The stereoblock polymers can be varied from hard, highly crystalline, thermoplastic materials of relatively high tensile strength, to less crystalline materials having mechanical properties similar to those of leather, and ultimately to elastic, rubberlike materials (22).

The mid-1957 rate of production of Ziegler polyethylene and polypropylene in Germany (Farbwerke Hoechst AG.) was reported to be about 2,500,000 lb. of polyethylene and 600,000 lb. of polypropylene per month. Production in 1958 is expected to be about 60 million lb. of polyethylene and 30 million lb. of polypropylene. Yield of polymer per part of catalyst has been increased from the early patent claims of 60:1 to plant yields of 1000:1 for polyethylene and 600:1 for polypropylene. This has resulted in less contamination of polymer with catalyst and lower costs. Better control of molecular weight has been achieved by the use of chain transfer agents to break the chain off the catalyst. Detailed systematic studies of environmental stress cracking of these polymers have shown that localized crystallization in the scanty amorphous areas present is probably a major factor; it has been possible to overcome this defect by plasticization, introduction of fillers, and cross-linking (23).

Polypropylene: Two types of polypropylene, differing in molecular weight, are being produced in Italy (Moplen, Montecatini). The lower-molecular-weight material has greater fluidity when molten and is especially suitable for the manufacture of film and blown containers. The higher-molecular-weight material is supplied for injection molding and extrusion. Specific gravity is 0.90 to 0.91; elongation at break 500 to 700%; crystalline melting point 327 to 338° F. An important characteristic is their thermal resistance which is well above 212° F., so that parts made from them can be sterilized or used with boiling water. Dimensional stability under no load conditions is maintained up to 300° F. Dielectric properties are excellent. Polypropylene is resistant to attack by most chemicals, including concentrated sulfuric and nitric acids at room temperature.

The density of polypropylene in the solid crystalline state (0.935) is higher than that in the amorphous state (0.87), but the difference is less than that for polyethylene (0.99 for the crystalline and 0.85 for the amorphous). The chains of polypropylene are thought to be largely spiral-shaped, with a low entropy, even in the liquid state. The high melting point of polypropylene is ascribed to the low entropy variation accompanying the melting (24).

Radiation effects

Many studies relating to the radiation chemistry of polymers were reported (25-28). Exposure of a standard grade of polyethylene to 8 to 16 million r. from an accelerator 1) effected a marked increase in tensile strength without any significant loss in elongation, 2) converted a material of poor crack resistance to one that has complete crack resistance, 3) markedly increased the heat distortion temperature of the polymer, and 4) improved its weathering characteristics (29). The effects of gamma radiation of 10^6 to 10^8 r. on thermally cured epoxy resins were investigated. Epoxy resins are highly radiation resistant when relatively inert aromatic-type curing agents are used. Heat distortion temperatures and compressive properties are little changed by radiation; hardness properties are most affected and can be used as a measure of radiation resistance (30). Other authors reported on the irradiation of polyethylene (31-34), polyesters (35), polymethyl methacrylate (36), polystyrene (36), cellophane (37), and rubber (38).

The application of ionizing radiation to the production of block and graft copolymers has been reported by several laboratories (39-43). A new field of copolymers is being opened up in which not only can the vinyl polymers be chemically combined into copolymer molecules of new

Directional sign for New York Thruway is fabricated by cementing acrylic letters to acrylic sheet (Ref. 49). Such signs constitute a major market for acrylics. (Photo, Rohm & Haas)

shapes and properties, but also in which the condensation-type polymers can be joined to addition-type polymers to give a new family of copolymers. The properties of polyethylene-vinylcarbazole, polybutadiene - styrene, polystyrene-butadiene, and polydimethylsiloxane - acrylonitrile graft copolymers were described (44).

Data on the thermal ignition and response of 900 samples of plastics under atomic blast conditions were obtained in test stations located 6600, 7660, and 8960 ft. from the bomb. The thermoplastics were affected by the thermal radiation of the nuclear weapon to a greater extent than were the thermosetting plastics. White and transparent specimens exhibited less distortion, char, and melting than did the dark colored and black specimens (45). Another phase of nuclear research on plastics involved the use of acrylic, epoxy, polyethylene, and polyester materials in the construction of a high-energy accelerator (46).

Materials

Acrylics: Thermoformed acrylic sheet products with principal markets in signs, displays, and lighting applications stand second only to high-impact styrene in the forming business; about 20 million lb. of acrylics were used for this purpose in 1956 (47-49). An acrylic-modified polyester improves the clarity and weather resistance of translucent reinforced plastics building panels. The acrylic component brings the refractive index of the resin closer to that of the fibrous glass reinforcement, making it less visible and the panel more transparent (50). Other reports dealt with acrylic coatings (51), models for design work (52), service temperature characteristics of molded parts (53), gating of molds for acrylics (54), fatigue testing (55), dielectric studies (56-58), and glass transitions of the poly-*n*-alkyl methacrylates (59). Materials studied included polymethyl methacrylate (60, 61), acrylonitrile polymers and copolymers (62-66), polyacrylamide (67, 68), polymethacroyl chloride (69), and polyethyl methacrylate (70). Multiple-beam interferometry and electron microscopy were used to ascertain the characteristics and mechanism of crazing in polymethyl methacrylate; each surface crack was found to be surrounded by a raised area which increased with the size of the crack. Because the dimensions of all observed cracks could be resolved in the electron microscope, it was concluded that plastics have a minimum craze-crack length (71).

Cellulosics: In the nine-year period ending with 1956 production of sodium carboxymethylcellulose expanded over 12-fold,

Thin paraboloid of epoxy cast on mercury rotating at 180 r.p.m. (Ref. 124) has focal length of 0.55 inch. (Photo, University of Calif.)

from 2,260,000 lb. to about 30,000,000 pounds. The primary markets for the technical grade are soaps and detergents, acting as a soil-suspension agent; the purified grade is used in the manufacture of ice cream and related products (72). The manufacture of ethylhydroxyethylcellulose in Sweden was described (73). The properties of fully substituted amylose acetate-butyrate, formate-acetate, formate-butyrate, formate-benzoate, and acetate-propionate esters were determined; they were generally soluble in organic solvents, formed films with good strength and plasticity, and appeared suitable for thermoplastic molding (74, 75). The creep of cellulose nitrate (76), the acetylation of cellulose (77), sorption and diffusion in ethyl cellulose (78), and transitions in cellulose acetates (79) were investigated. The role of butyrate in piping and linings for steel pipe to transport sour crude oils, natural gas, and salt water was discussed (80).

Epoxies: The versatility and growing commercial importance of epoxy resins was evidenced by the voluminous literature that appeared on this subject in 1957. A wide variety of curing agents were evaluated (81-88). Effects of fillers and reinforcements on properties of epoxy compounds were investigated (89-91). Epoxy resins were used to react with and modify the properties of polyamides (92), synthetic rubbers (93), adduct of maleic anhydride and hexachlorocyclo-pentadiene (94), butadiene (95), polysulfides (96), styrene oxide (97), fatty acids (98, 99), and alkyds (100, 101). The many applications described included tooling (102-109), electrical encapsulation (110-113), cements (114-117), surface coatings (118, 119), sealants (120, 121), reinforced pipe (122), and chemical plant equipment such as tanks, product carriers, exhaust stacks, and impellers (123).

An interesting development involved the use of epoxy resin cured while spinning, then plated to produce inexpensive, high-grade mirrors without grinding and polishing operations. The process utilizes the principle that a liquid in a revolving horizontal pan takes the shape of a paraboloid; the epoxy resin provides a casting material characterized by high strength, low shrinkage, and an extremely smooth, glass-like surface when set (124).

Epoxy resins also offer great promise in three-dimensional photoelastic stress analysis because of their high deformation sensitivity and because they can very readily be cast in large sizes. A resin prepared with 100 parts by weight of basic epoxy compound and 50 parts of phthalic anhydride has a fringe/in. value of 2235 compared to 365 for the formerly used glyceryl-phthalate resin (125).

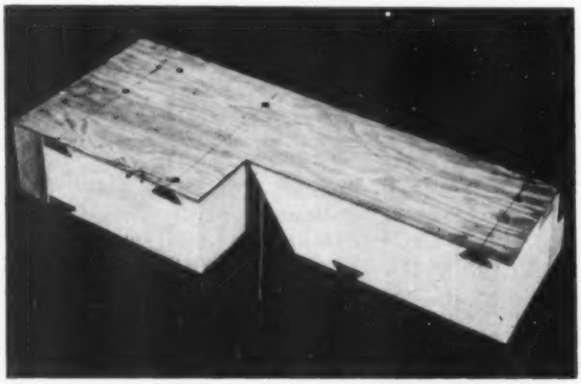
The heat distortion properties

of a large number of epoxy resin-catalyst systems were studied (126, 127). Infra-red spectroscopy was used to investigate the curing reactions of epoxy compounds (128, 129).

Ethylene polymers: Polyethylene continued to occupy the spotlight among the big three of the thermoplastics and approximated, if it did not overtake, the styrene group in annual volume of production, over 600 million lb. The low-pressure product has yet to become a major factor in the field, accounting for less than 20 million lb. in 1957 (130).

New and expanding markets are essential in the immediate future for polyethylene. One of these is in the construction industry where end uses include: 1) moisture barriers in home basements, crawl spaces, slabs, floors, walls, and ceilings; 2) in concrete work as form linings and for curing; and 3) as protective coverings for machinery, materials, and buildings under construction. Consumption of film in these applications was estimated at 15 million lb. in 1956 and is expected to reach 50 to 60 million lb. by 1960. Important factors in the use of polyethylene film in construction is its moisture-proofness, ease of handling, strength, tear resistance, and durability (131-133).

Another big market for polyethylene film is in agriculture. Research at argricultural experiment stations has shown that this film provides a low-cost and efficient material for mulches and plant covers, silos and crop covers, and glazing for greenhouses (134, 135). Polyethylene is reported to account now for over 70% of plastics houseware items (136). Polyethylene film provides a low-cost, readily fabricated material for weather and observation balloons; the envelope of the Super Skyhook I, which set a new record of 117,000 ft. for unmanned balloons, had a capacity of 3,200,000 cu. ft. and weighed only 850 pounds (137). Insulation on wire and cable ranks as one of the major markets for polyethylene; 38 million lb. were used for this purpose in 1955 (138, 139). Pipe (140-144), fibers (145), packaging (146-149), grids for water-cooling towers (150), and disposable items such as drapes, tablecloths, and place settings (151) are among other major applications for polyethylene (152, 153).



Section of large (65- by 58- by 4-in.) sandwich panel consists of urethane foam core of 1.8-lb./cu. ft. density and ⅛-in. plywood faces (Ref. 217). Photograph shows the complete absence of voids. Bond between plywood faces and urethane foam is stronger than the foam itself. (Photo, Allied Chemical & Dye)

The manufacture of the new linear high-density polyethylenes was discussed by various authors (154-162). Structure, composition, and property relationships were intensely explored (163-170). Environmental stress cracking (171), permeability to liquids and gases (172-175), low-temperature brittleness (176), and specific heat (177) were among the many physical properties investigated (178-181). The addition of low-molecular-weight polyethylene to the high-molecular-weight product is reported to improve flow characteristics, color dispersion, gloss, and mold release (182).

The injection molding (183-185) and extrusion (186, 187) of polyethylene, particularly the new linear type, were likewise the subjects of concentrated attention. A novel process heat-seals molded hollow polyethylene parts together to produce bowling pins, battery containers, and balls (188, 189). A large percentage of polyethylene is delivered to molders uncolored; compounders in these plants were provided with helpful guidance in the choice of colorants which are greatly affected by processing factors such as temperature, time, and type of mixing equipment (190).

Fluorocarbons: Teflon and Kel-F compositions were found to be suitable for use as oil-free bearings in aircraft clocks and similar instruments in which lubricated jewels do not give satisfactory service at the sub-zero temperatures encountered (191). The uses of polytetrafluoroethylene in gaskets (192, 193), wire insulation (194), printed circuitry (195, 196), and molded parts (197, 198) were discussed. Permeability (199), wettability and friction (200), and glassy state transitions (201) were among the properties of fluorocarbons investigated (202). New fluorine derivatives include polyethers (203), polyesters (204), and perfluoroalkyl silanes (205).

Isocyanate polymers: Mass-produced foams, both rigid and flexible, continue to be the major outlet for polyurethanes made by the reaction of isocyanates with polyesters or polyethers (206-208). Chemicals used in the production of foams have been standardized; high-speed equipment has been developed for handling the foamable liquids (209-215). A mixture of dibasic and tribasic acids made by polymerization of 18-carbon unsaturated fatty acids is providing competition to the low-cost polyethers in

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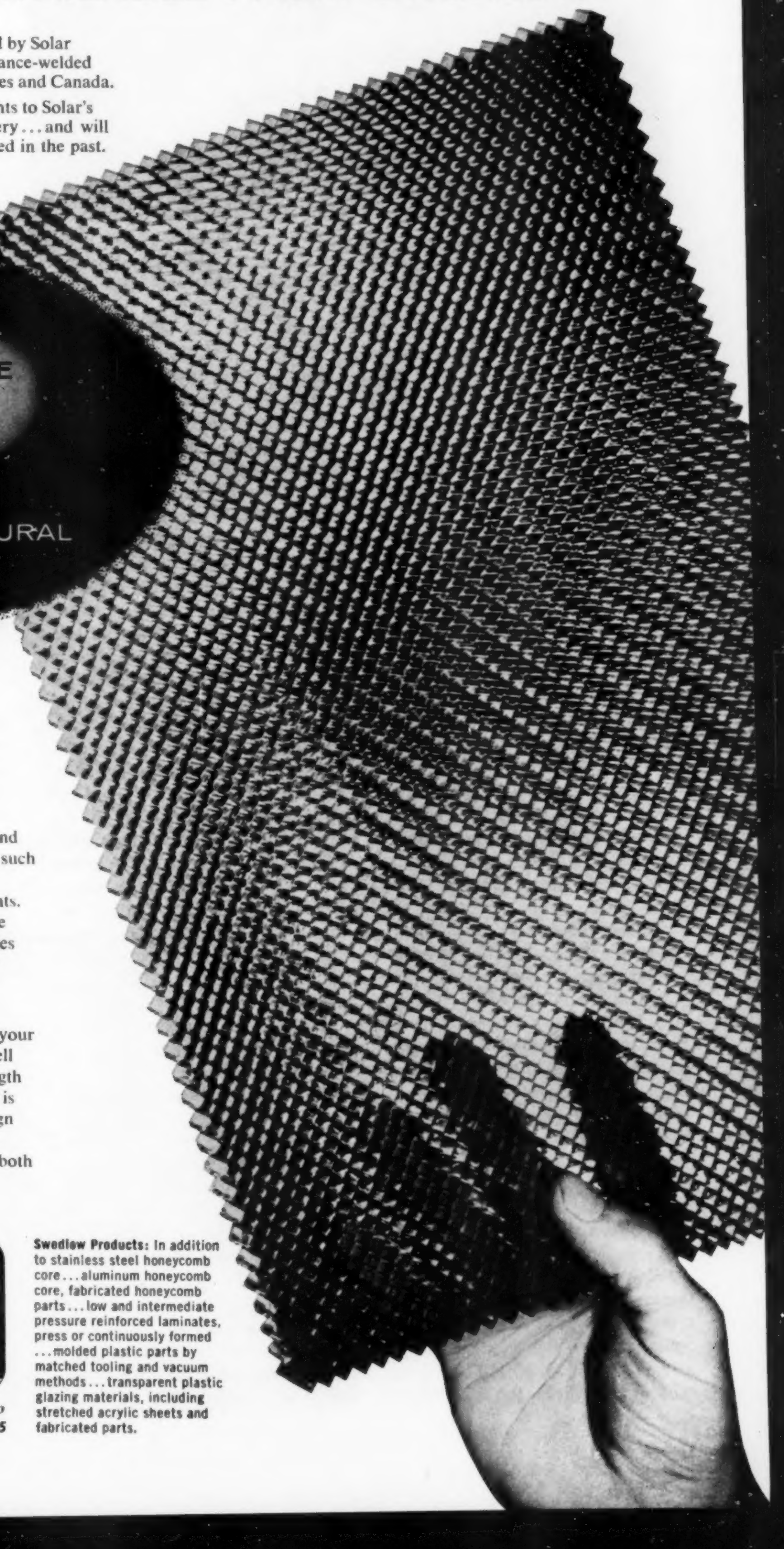

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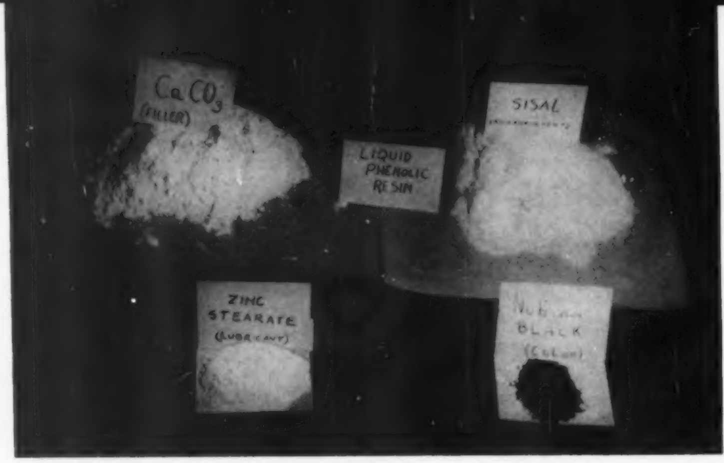


Ingredients for phenolic premix (Ref. 225) include sisal reinforcement, liquid phenolic resin, calcium carbonate filler, zinc stearate lubricant, and nubian black pigment. (Photo, Allied Chemical)

the manufacture of low-density flexible foams (216).

The rigid polyurethane foams are used in aircraft and missile construction, nuclear devices, and refrigerator insulation (217); the flexible foams are used in cushioning applications (218). The isocyanate polymers are also finding major outlets in elastomeric products (219, 220), protective coatings (221, 222), and electrical insulation (223,224).

Phenolics: Compounding of thermoset molding powder by the molder, developed so successfully for the polyesters, has been extended to the phenolics; costs, recipes, equipment, premixing temperatures and cycles, and some proved applications were described (225). The quantitative aspects of preform temperature, mold temperature, molding pressure, and cure time on the shrinkage of molded parts were explored (226). A low-cost reinforced molding compound contains about 47% cellulose and 45% lignin (227). Epoxy coatings have been developed for permanent application of color to glossy phenolic surfaces (228). Other reports on phenolics dealt with molding problems (229, 230), testing (231-235), baking finishes produced by combination with polyamides (236), and linear phenol-formaldehyde polymers (237).

Polyamides: Developments pertaining to the four commercial types of nylons were reported; namely, the 6/6 based on adipic acid (238, 239), the 6/10 based on sebacic acid (230), the 6 based on caprolactam (240, 241), and the 11 based on amino-undecanoic acid (242). A new nylon prepared by the reaction of *m*-xylylenediamine and adipic acid crystallizes readily on annealing, has a heat distortion temperature over 392° F., and has a crystalline melting point of 469° F.; it is considered to offer promise for use in fibers, films, and molding materials (243). Sintered nylon has superior frictional and wearing qualities and higher compressive strength, but lower tensile strength, elongation, and impact strength than injection molded nylon; additives and fillers are easy to blend with the fine nylon powder used in this process. Present applications for sintered nylon parts are in cams, slides, rollers, and bearings used in business machines, automotive equipment, airplane instruments, and textile machinery (244). Other reports related to the properties (245-248) and uses (249-252) of nylon resins.

Polyesters: Premix molding compounds accounted for the use of 20 million lb. of the 73 million lb. of polyester resins produced in 1956. The selection of resins, fillers, mixers, and processing conditions to achieve satisfactory mixing, storing, preforming, and performance in the finished product was discussed (253, 254). Polyesters were described for use in molding compounds (255, 256), laminates (257), and foamed plastics (258). A short-time flexural creep test was used to evaluate polyesters in reinforced plastics (259). The preparation of polyesters with various raw materials (260-262) and catalysts (263) was reported. Methods for the measurement of degree of cure were described (264, 265).

Polyethylene terephthalate (Mylar) film was evaluated for military greaseproof barrier material (266) and metallized capacitors (267). The energy to rupture, the strain at rupture, and the residual strain of polyester film were found to be roughly 25% less at rates of straining of 400,000 to 800,000% per min. than at rates of straining of 1 to 100% per minute (268). Studies of orientation (269), infra-red spectrum (270), and pyrolysis (271) of polyethylene terephthalate were published. Problems in machine handling of polyester film were examined (272).

Silicones: The chemistry, properties, and applications of this important class of high-temperature-resistant materials were covered in a noteworthy review (273). Special reports dealt with silicones in protective coatings (274), brakes (275), electrical insulation (276), and rubber products (277, 278). Several new compounds were described (279-281).

Styrene polymers and copolymers: Polymethylstyrene and a methylstyrene-acrylonitrile copolymer are the newest commercial thermoplastics of this group. Polymethylstyrene has a heat distortion temperature as high as 338° F. and can be boiled in water for 30 min. or longer without distortion. It is also outstanding in solvent resistance and hardness. The copolymer of methylstyrene with 30% acrylonitrile has greater toughness and tensile strength than polymethylstyrene and has comparable heat resistance, solvent resistance, and molding characteristics. Both materials are suggested for use in industrial and machine parts, radio cabinets, and housewares (282, 283).

Developments reported for polystyrene (284) related particularly to its use in piping (285, 286) and as a foamed insulating material (287-289). Many papers dealt with the molecular and solution properties of polystyrene (290-294). A technique for determining densities of latex particles to seven significant figures

was described (295). Isotactic polymers of o-methylstyrene, o-chlorostyrene, and p-fluorostyrene are reported to have melting points higher than 572° F. and to crystallize much better than isotactic polystyrene (m. p. 440 to 464° F.); they have been suggested as potential bases for fibers of high heat resistance (21).

Styrene alloys continued to make news in various applications. More than 6000 miles of pipe have been made from acrylonitrile-butadiene-styrene (ABS) blend in the past ten years (296). The pipe is tough and stiff, and can be easily handled in lengths up to 30 feet. Its primary installations are in natural gas lines, oil fields, sewage treating systems, and chemical plants. A new thermoformable fire-resistant sheet composed of styrene and vinyl resins is reported to have outstanding properties and to be readily fabricated by all conventional methods (297). Test methods to determine impact strength (298) and effect of plasticized vinyls on styrene plastics (299) were outlined.

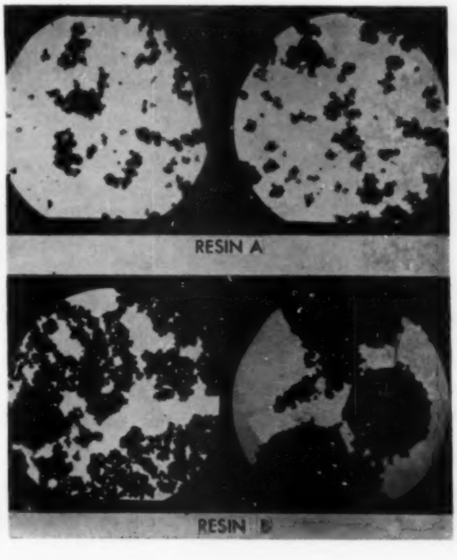
Vinyl polymers and copolymers: Production of vinyl plastics exceeded 750 million lb. in 1956, to keep this material in the No. 1 spot among all plastics. Calendered material reached 175 million lb. in 1956, floor covering 65 million lb., and wire coating resins 80 million pounds. Wall coverings offer promise as another big market for vinyl resins (300). Other applications that utilized the versatile properties of vinyls included valves (301), hose (302), offset lithography (303), pipe (304), flooring (305), packaging film (306), electrical conduits (307), and roofing (308). Radioactive carbon-14 was used to establish the fact that polyvinyl alcohol was not extracted from films by edible fats and oils, thus permitting its use as a component of wrappers for fatty foodstuffs (309, 310). Adhesives for vinyl film laminations and evaluation techniques for such products were discussed (311, 312). Two new British Standards were issued for thin and thick flexible polyvinyl chloride sheeting (313). Plastisols were described as probably the most versatile group of materials in the plastics family, convertible into coatings and moldings by application of heat alone (314).

The chemistry and properties of vinyl polymers were covered in reports concerning polyvinyl chloride and its copolymers (315-317), polyvinyl alcohol (318), polyvinyl pyridine (319), polyvinyl pyrrolidone (320, 321), polyvinyl acetate (322-324), and other vinyl polymers (325-328). Testing methods and data were reported for electrical properties (329, 330), heat stability (331), and rheological performance (332, 333) of polyvinyl chloride compounds. Problems in compounding with fillers (334), plasticizing (335), and welding (336) were considered.

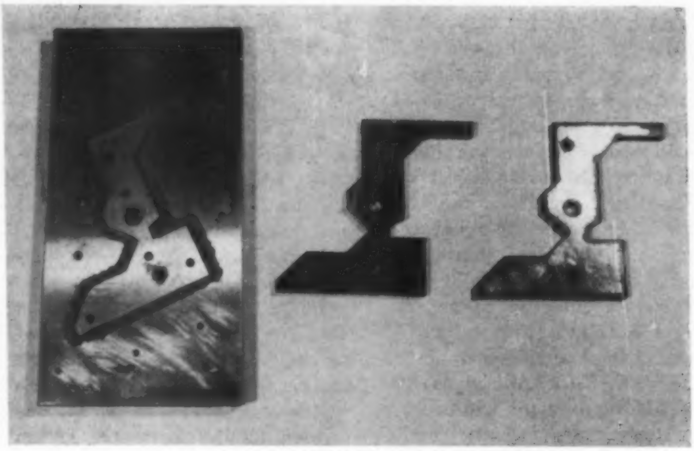
Other polymers: Rapid high-frequency preheating of urea molding compounds to 160 to 170° F. has been found to be practical in the compression molding of large housings (337); this technique was previously restricted to phenolics and melamines (338) which have longer induction periods. Plastic compositions made by compounding aniline, melamine, and urea resins with rubbers were described (339). New types of ion exchange resins (340, 341) and new uses for these materials (342) were investigated. Reports on new rubbers included cis-polyisoprene (343), carboxylic rubbers (344), polyalkylene disulfides (345), chlorinated polybutadiene (346), and polymethyl methacrylate grafted on rubber (347). Other materials dealt with in the literature included polypropylene oxide (348), coumarone-indene resins (349), inorganic polymers (350), and vulcanized fiber (351). Various polymerization phenomena were described (352-354).

A noteworthy paper reviewed the principles involved in designing polymers to obtain plastics with useful properties and ready processability. Three features of molecular structure—namely, degree of polymerization, width of molecular weight distribution, and density—were shown to affect plastics properties in significant ways. In the case of polytetrafluoroethylene, physical form also makes a major contribution to properties of the molded product (355).

Reinforced plastics: Recent technical and commercial developments in raw materials and resins used in reinforced plastics were detailed in a comprehensive review covering polyesters, phenolics, and epoxies. High heat resistance and high modulus, both needed in missile and aircraft applications, have given new impetus to reinforced phenolics. The epoxies provide low shrinkage on curing with resulting improved adhesion to glass and better water resistance. The price factor and versatility in formula-



Photomicrographs of two plastisol resins, 1130X (Ref. 332). The two photographs of each resin reflect the average picture obtained by 12 photographs made of each sample. These pictures shed light on the problem of the effect of resin on the flow properties of plastisols. (Photo, General Tire & Rubber)



Epoxy-faced tracing templet at right (Ref. 369) is produced by casting resin around rough-sawed steel plate (center) in aluminum master at left. (Photo, General Electric Co.)

tion and processing have given the polyesters their present position of leadership in this field (356). Glass flake has been found to yield laminates characterized by extreme stiffness, ability to absorb energy, and economy in fabrication (357). Progress in the development of silane finishes for glass fibers was reviewed (358, 359). Laminates prepared with asbestos and phenolic and silicone resins were described (360).

The potential as well as the current applications of reinforced plastics continue to capture the imagination of engineers and designers. One authority on missile requirements foresees the possibility of 85% of the airframe being composed of structural plastics. Although temperatures under consideration are 1500 to 5000° F., the low thermal conductivity of reinforced plastics would allow the surface of the component to suffer the extreme high temperature exposure without exceeding the mechanical properties temperature limit of the load-carrying interior of the laminate. He urges a major research effort to double the strength of presently available materials at elevated temperatures (361). Another report described highly efficient heat barriers for aircraft parts, obtained by coating fibrous glass laminates with thin reflective coatings (362). The largest reinforced plastic airborne part, a radome for a military radar picket airplane, was designed, tooled, molded, and installed in 120 days (363).

Residential swimming pools are being made of reinforced plastics by about 12 companies; types of construction and the necessity for top-quality fabrication and installation were considered in a survey of this market (364). New reinforced plastics parts in 1957 cars included a hardtop, a hood overlay, and truck grilles (365). Molded modular panels are gasketed and bolted together to form liquid-holding tanks of any size; one of 50,000-gal. capacity is in use (366). Other noteworthy reports on applications of reinforced plastics pertained to piping (367, 368), tooling (369), printed circuits (370, 371), aircraft and automotive parts (372-374), reflectors (375), mapping on large-diameter surfaces (376), awnings (377), and safety helmets (378).

Directionally reinforced molding materials now make it possible to develop, even in complex structures, patterns of strength corresponding closely to the expected pattern of stress in service; detailed instructions are given for designing molding, machining, and finishing such parts (379). Outstanding contributions to fabricating techniques covered preform automation (380), pressure preforming (381), molding with polyvinyl alcohol membranes (382), spin molding radomes and tanks (383), filament winding for hollow structures (384), and the use of veils or fabric overlays to apply gel coats to reinforced plastics moldings (385). Various other problems in the design and manufacture of reinforced plastics were considered (386-388). Factors involved in cost estimating in this field were dealt with in detail and the process was illustrated by many sample forms (389).

Many new data were published on the mechanical properties of glass-fiber laminates (390-394). A comprehensive investigation of fatigue properties covered the range from 1000 to 10 million cycles and included the effects of notching, moisture, fabric construction, type of resin, mean stress level, and temperatures up to 500° F. (395). Another group of reports presented significant new data on the resistance of reinforced plastics to elevated temperatures (396-404). The basic properties that affect performance of reinforced polyester plastics in chemical applications were discussed; typical applications considered were alum evaporators, stacks, dryer trays, filter troughs, and filter press plates (405).

Foamed plastics: Two major surveys dealt with the economic and end-use status of flexible and rigid foamed plastics, respectively. Polyurethane dominates the flexible plastic foam picture (8 to 10 million lb. in 1956, 25 to 35 million lb. in 1957) with vinyl running second (3 million lb. in 1956, no estimate for 1957); rubber foam consumption has been running about 250 million lb. annually. The switch from polyester to polyether for reaction with the isocyanate has recently pulled the price of urethane foam below that of rubber foam. Big markets for flexible foams are available in cushioning for furniture and automobiles, garment linings, mattresses, and carpet underlays (218). The list of rigid plastics foams includes ten basic materials—styrene, urethane, vinyl, cellulose acetate, epoxy, phenolic, ethylene, silicone, urea, and polyesters. Styrene foam has reached substantial volume (12 million lb. in 1957) and is said to be outselling cork on a board-

foot basis for insulation and flotation uses. A new 10 million-lb. capacity plant for producing expandable beads for foamed-in-place applications is expected to be in operation early in 1958. Rigid urethane foam has greater heat resistance, structural strength, and vibration resistance than does styrene foam; it should grow rapidly from its 1957 production position of less than 1 million lb., particularly as lower-cost raw materials are developed (217). Blowing agents (406, 407), manufacturing methods (408, 409), and various uses (410-413) were described by other authors.

Sandwich construction employing reinforced plastics skins and foamed plastic was used in the fabrication of the Monsanto "house of the future" which is now on exhibition in Disneyland (414). Sandwich material was also used in building two 36-ft. waterjet landing craft for the U. S. Navy (415). A refrigerated cargo carrier box 17 ft. long, 8 ft. wide, and 8 ft. high (416) was among other applications of sandwich structure (417, 418). A simple method for calculating the thermal conductivity of plastic honeycomb sandwich was published (419).

Plasticizers, stabilizers, etc.; The production of plasticizers in 1956 remained at about the 400 million-lb. level, with the phthalates accounting for about 60% of the total (420). Isosebacate plasticizers (421), plasticizers for use by the food industry (422), and attack of plasticizers by fungi (423) were among special topics considered.

An extensive review of materials and factors involved in the stabilization of plastics was presented (424). Other articles were concerned with metallic soaps (425), dialkyltin compounds (426), and substituted benzophenones (427) as stabilizers.

The many roles of pigments and fillers in plastic compositions received attention (428, 429). A polymerized fatty acid was introduced as an intermediate for the manufacture of polyesters, polyamides, plasticizers, etc. (216, 430).

Processing

Design (431-433), casting (434-436), and repair (437) of molds received attention. Improved methods for predrying hygroscopic molding materials (438) and controlling mold temperatures (439, 440) were described. Significant advances were made in the techniques of compression molding (441-446), injection molding (447-459), extrusion (460-471), molding of reinforced plastics (379-389, 472-477), and vacuum forming (478-485).

Developments were reported in casting of resins (486, 487), molding hollow shapes (488), film manufacture (489-491), heat sealing (188, 189, 492), vacuum metallizing (493), and application of plastic coating to metals (494, 495). Improvements in drilling (496), cutting (497, 498), machining (499), and welding (500) of plastics were described.

Agricultural applications of polyethylene film (Ref. 314) include use in trench silo. (Photo, Visking Corp.)

Problems in dealing with combustible dust hazards in plastics plants were surveyed (501). Fast and efficient methods and equipment have been developed for the storage and handling of laminates in warehouse operations (502).

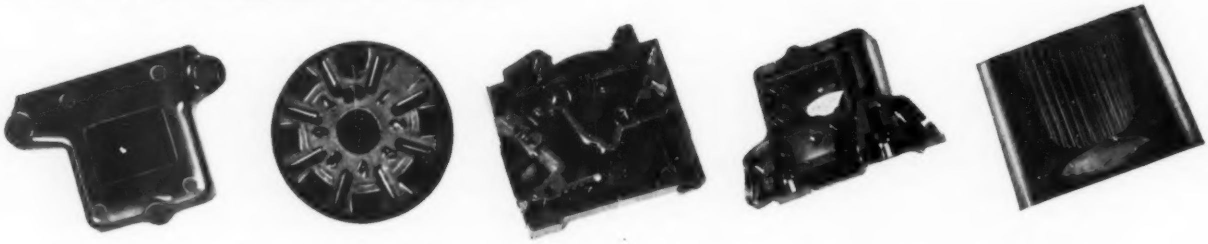
Applications

Agriculture: It is predicted that millions of acres of crop land will be covered with polyethylene film in the next decade to conserve moisture and soil, to lower labor content of crops, to increase production, and to bring about significantly lower costs. Black polyethylene film is reported to be the cheapest and most efficient mulch available, preventing growth of weeds, promoting early ripening, and protecting the produce from rotting in contact with moist soil. Both vinyl and polyethylene films have demonstrated their adaptability for silo covers and construction of inexpensive silos. Greenhouses built by covering a wood framework with polyethylene film are estimated to cost $\frac{1}{6}$ to $\frac{1}{20}$ as much as a glass greenhouse and to cost half as much to heat. Reinforced plastics panels and styrene-acrylonitrile oriented sheeting are also finding use as transparent materials for greenhouse construction. Increased use of plastics is foreseen in water conservation, irrigation, land drainage, erosion control, control of pests, protection of farm machinery, produce storage, and marketing (134, 135, 503).

Aircraft: The present and potential uses of reinforced plastics in missiles indicate an important role for these materials in this rapidly growing branch of the aircraft industry. Glass fibers bonded with silicone, phenolic, and polyester resins provide insulative structures that can withstand for short periods the extremely high temperatures encountered in missile operations (504). Hollow structures created by filament winding possess high strength, light weight, and corrosion resistance; they have proved to be suitable for pressure vessels for containing rocket fuels (384). Reinforced plastics are regarded as a promising field for increased research efforts to provide a high-

(*To page* 166)

MORE FREEDOM IN MOLDING!



DECREASE IN CURE TIME	DECREASE IN CURE TIME	DECREASE IN CURE TIME	DECREASE IN CURE TIME	DECREASE IN CURE TIME
27%*	17%*	20%*	40%*	60%*

Small electrical parts molded of BMM-7000 show its fidelity to mold details, its surface gloss, and its suitability for complex mold designs, all with the added advantages of wide molding latitude and fast production rates.

*Compared to previously used material

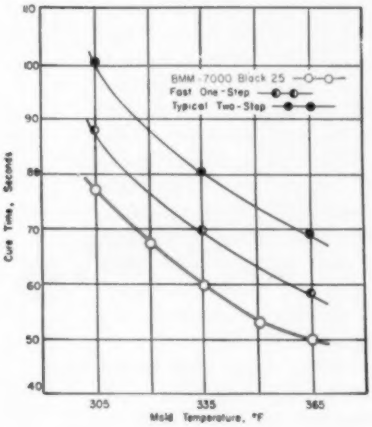
cures faster than any other general-purpose phenolic...

BAKELITE BRAND COMPOUND BMM-7000

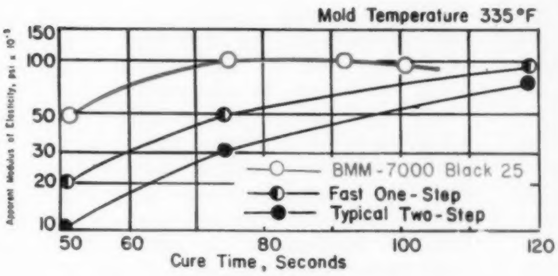
...a general-purpose two-step wood-flour filled phenolic molding material. Its cure speed is exceptional—faster than either two-step or very fast one-step materials.

Intended for cold powder automatic molding, BMM-7000 can also be plunger molded on fast cycles.

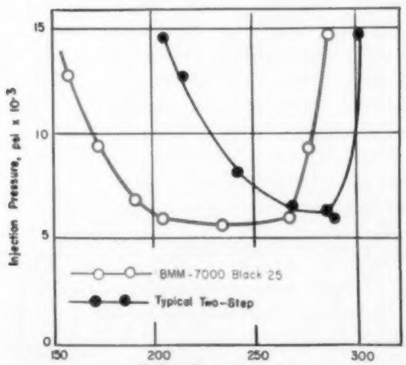
FAST CURE SPEED—BMM-7000 cured as fast at 315 deg. F. as a fast one-step material at 335 deg. F., and a two-step material at 365 deg. F., according to a test of minimum blister-free time in cold powder compression molding.



HOT RIGIDITY—BMM-7000 took 50 seconds to reach an apparent modulus of elasticity of 50,000 psi at 335 deg. F. A fast one-step phenolic took 50 per cent longer, a typical two-step material, 100 per cent longer.



MOLDING LATITUDE—As determined by plunger molding, BMM-7000 could be preheated over a wider range than general-purpose BMG-5000, and still give mold fill-out—an 87 deg. F. spread at 7500 psi, compared to 46 degrees for BMG-5000. This property makes the new material suitable for molding large pieces even with its fast cure speed.



IN ADDITION—BMM-7000 demonstrates good mold release, freedom from mold staining, low specific gravity, and low shrinkage.

TYPICAL TEST VALUES OF BAKELITE BRAND GENERAL-PURPOSE PHENOLIC COMPOUND BMM-7000

BMM-7000 BLACK 25 TYPICAL TEST VALUES

VALUES RELATING TO FABRICATION

Granulation (D392-38)	12 mesh*
Bulk Factor (D392-38)	2.3
Tabletting Qualities	Easily preformed on standard equipment.
Pourability (D392-38), sec.	19
Plasticity Grades Available	6, 9, 12
Molding Shrinkage (D955-51), in./in.	0.004

*All grades supplied in special low fines granulation.

VALUES FROM ELECTRICAL TESTS

Dielectric Strength (D149-55T) Short time, volts/mil	330		
Volume Resistivity (D257-54T) ohm-cm	6×10^{12}		
	60C	1 KC	1 MC
Dielectric Constant (D150-54T)	6.1	5.7	4.6
Dissipation Factor (D150-54T)	0.08	0.04	0.03

VALUES FROM MISCELLANEOUS TESTS

Molded Specific Gravity (D392-38)	1.36
Heat Distortion Temperature (D648-45T) deg. F.	330
Water Absorption (D570-54T) % wt. gain	0.5

VALUES FROM MECHANICAL TESTS

Izod Impact Strength (D256-54T) (Ft. lb./in. of notch)	0.29
Compressive Strength (D695-54), psi	35,000
Tensile Strength (D651-48) (⅛"), psi	6,900
Flexural Properties (D790-49T): Flexural Strength, psi	9,000
Modulus of Elasticity in Flexure, psi	9.5×10^5

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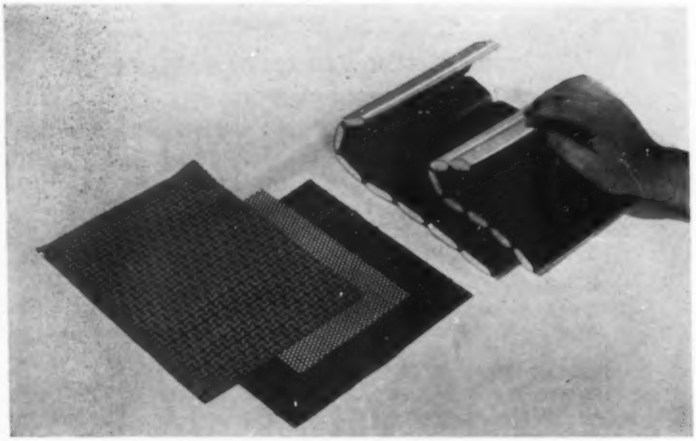

Air-permeable vinyl fabrics (Naugahyde, at left) and quilted vinyl incorporating vinyl foam (Bolta Foam-Quilt, at right) are among newer materials available for automotive upholstery. (Ref. 509)

strength heat-resistant material needed for the airframes of the large-size, long-range high-velocity missiles assuming prominence today (361). Nose cones and airframes of long-range guided missiles can reach temperatures up to 10,000° F. in flight. In addition components and structural members in the power plant often are subjected to high temperatures caused by high-energy fuels. Reinforced plastics are among the materials that promise to stand up under such temperatures. It has proved possible under flight conditions to bring the surface of the plastic to its degradation point while the rest of the material gave the required performance (399).

Various aircraft applications of plastics were described (505, 506), including a 50-lb. vinyl-coated nylon cover for the 45-ft. long corporal missile (507), a crash helmet assembled from 12 plastics components (508), a 3-ton radome for a radar picket airplane (363), heat shields (362), rotor blades for turbojet engines (374), and foamed plastics for aircraft seats (411) and for protective containers for photographic equipment jettisoned from missiles (410).

Automotive: The trend toward increased use of reinforced plastics in body components was pointed up by the one-piece hardtop made for the Ford Thunderbird and the hood overlay for Studebaker's 1957 version of the Golden Hawk sports car (365). Grilles for the International Harvester and Studebaker-Packard trucks further emphasize the toughness and economical tooling costs associated with the use of reinforced plastics (365). A wide variety of calendered, extruded, woven, cast, coated, and laminated vinyl materials were used in the 12.5 million seat covers sold in 1956, representing a $250 million market (509). A combination of rigid vinyl and braided glass filaments in battery plates provides 40% more power in truck batteries (510). Many developments were reported in the use of reinforced plastics for commercial vehicle bodies (372, 373, 511-514).

Building: The unlimited formability and fabricability of plastics were utilized in the design and construction of a house made up of a few large parts rather than many small ones. Rigidity rather than strength dominated the design. The house is now on exhibit in California (414, 515). Vinyl-coated nylon fabric was used in the fabrication of portable warehouse structures held up by low-pressure air (516) and a Marine Corps shelter of geodesic design which weighs about $\frac{1}{4}$ as much as an equivalent conventional shelter and costs about $\frac{1}{8}$ as much (517). The new Monsanto research laboratory in St. Louis incorporated 80 different applications of plastics, including exterior use of reinforced polyester panels and polyester-faced concrete blocks, acrylic windows and louvers, foamed polystyrene insulation in the roof, and extensive installations of rigid polyvinyl chloride pipe (518). Polyethylene film 1 to 6 mils thick is being used in the building construction industry as a moisture barrier in place of paper products; an ultimate potential in excess of 100 million lb. annually is foreseen (131). Flooring (305), wall tile (510), roofing (308, 520), and exterior masonry (521, 522) are among the many other outlets for plastics products in the building field (523-526).

Pipe: More than 6000 miles of acrylonitrile - butadiene - styrene pipe are now in operation, carrying such diverse products as natural gas, salt water, crude oil, fruit juices, irrigation water, laundry cleaning compounds, battery acids, sewage wastes, and various types of chemicals (296). A 7-in. diameter polyethylene pipeline has been installed to carry saturated brine between two plants over a mile apart (140). A survey of reinforced plastics pipe showed that there are seven active producers, employing mandrel wrapping and centrifugal casting methods; in addition, there are some 10 other firms in development or pilot plant status. Standardization and improved production methods are needed to realize the tremendous potential market available for corrosion-resistant pipe (367). Other types of plastics pipe dealt with in the literature included cellulose acetate butyrate (80), polyvinyl chloride (304, 307), polystyrene (285), polyethylene (143, 144), and glass fiber epoxy (122, 368). The results of service experience with plastics piping were reported in many articles in consuming-industry trade publications (527-536). Nondestructive testing methods for plastics pipes were described (537).

Tooling: A saving of 20% or more in both time and cost by the use of plastics tooling was reported in the manufacture of jet engine parts; the tools, gages, and dies involved in this work are complex and require extremely

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close fabrication tolerances (369). Production of tools from epoxy resins (103, 104, 106, 108), epoxy-polyamide blends (109), and epoxy-polysulfide compounds (105) was described. These tools are especially useful for small-lot jobs and offer economy in fabrication, light weight, easy handling, quick modification for design changes, low cost, and stability (538-541).

Other applications: An interim report on the use of plastics in solar stills revealed that many types of film had been tested. Still needed is a thin film which is tough, wettable, with high transmission properties and excellent weathering resistance. A solar still using polytetrafluoroethylene as the transmitting and condensing surface and polyethylene as the "black" material is to be built and tested by the government (542). A solar stove to provide a low-cost heater for non-industrialized areas consists of a reflector formed of high-impact polystyrene and lined with aluminized Mylar (543).

Sixteen companies are engaged in the manufacture of plastics lenses in this country (544). Acrylics are becoming a major factor in sign developments (48, 49, 545). Furniture drawers (546) and industrial tote boxes (547) represent new important uses for plastics. Housewares (548, 549), fasteners (550), and disposable items such as picnic sets, drinking cups, covers of all sorts, medical items, and industrial caps (551) utilize a great variety of plastics in large amounts. The television (552) and motion picture (553) industries continue to find many unusual applications of plastics in scenery and props. Especially noteworthy are the advances being made in the production of polyester motion picture film (Cronar) which is outstandingly superior in folding endurance, tear strength, dimensional stability, and projection life. The U. S. Navy is conducting experimental construction and test programs on reinforced plastics landing craft which require high impact resistance and immunity from attack by fungus, worms, rot, and salt water (415, 554). Plastic implants in the human body (555), plastic teeth (556) and an inexpensive mask for protection against chemical and biological warfare (557) were described.

Advances in industrial uses of plastics were made in coal mining (558), gas metering and transmission (559, 560), paper manufacture (561, 562), packaging (422, 563-568), and electronics (110-113, 569-572). Recent progress in the development of synthetic fibers (573-576) was reported, in particular their use in felts (577) and carpets (578).

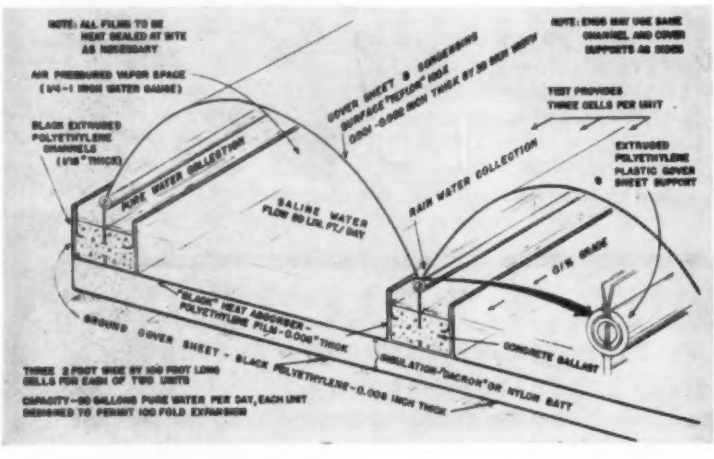
Adhesives: The expanding role of adhesives in industry was surveyed (579). Developments in radio-frequency bonding (580) and in applying adhesives (581) were described. Reviews were published pertaining to adhesives based on epoxy resins (117), vinyls (311), and rubbers (582); pressure-sensitive adhesives (583, 584); and problems involved in bonding to glass (585, 586), metals (587), and wood (588). Strength properties (589-592), strains (593), and solvent resistance (594) of adhesive bonds were investigated.

Coatings: New developments in this major market for synthetic resins were reported for acrylics (51, 595), polyvinyl acetate (595), epoxies (118), polyurethanes (221, 222), polyamides (251), silicones (274), alkyds (596), and strippable coatings (597). Advances in coating technology were reviewed (598-606). Methods were described for measuring adhesion of coatings to various substates (607-609) and for analyzing coating materials (610).

Properties

Many significant contributions were published on the mechanical properties of plastics, including tensile strength (393, 611-613), modulus of elasticity (170, 614, 615), dynamic modulus (70, 616, 617), flexural properties (390, 393), impact strength (393, 618, 619), stress cracking (171, 620), hardness (621), bulk compressibility (622), fatigue resistance (55, 392, 395, 623), and creep and stress relaxation (322, 394, 624-627). Other studies of mechanical behavior of plastics related to temperature dependence (176, 396, 398-400, 628), heat-aging (397), dielectric material (111, 629), and theoretical relationships (630, 631). The use of the photoelastic properties of plastics to measure stresses (125, 632-634) highlighted reports on optical properties (635-637). The permeability of plastics to gases and water vapor received the attention of many investigators (172-175, 199, 638-642). Other properties studied included dielectric behavior (58, 643-645), sorption of water and organic solvents (646, 647), degradation by ozone (648) and ultrasonic waves (649, 650), softening-point (651, 652), flammability (653), density (295,

Design of solar still developed by Du Pont and submitted to the government for building and testing (Ref. 542). Curvature of Teflon film is claimed to reduce incidence of droplet formation. Life of film is anticipated to exceed 10 years



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654), flow (655) and corrosivity (656). Special electronic methods for evaluating the quality of hi-fi phonograph records were described (657).

Infra-red spectroscopy (658-661) and micro-fusion (662) were among the methods described for the identification of resins (663, 664). Analytical procedures were described for the analysis of phenolic (234), urea (665), and urethane (666) resins and cellulose nitrate (667).

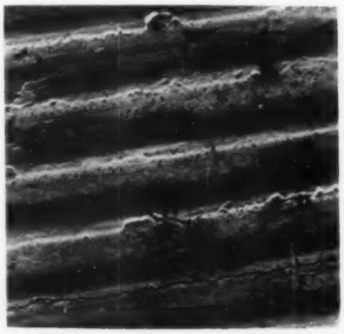
Various techniques were used to determine the molecular characteristics of polymers (688-671), including light scattering (672-674), viscometry (675, 676) and osmometry (677). Specific materials studied were polystyrene (678), acrylics (679), and cellulosics (680-685).

Standards

Six new commercial standards were approved during the year: CS214-57, glass-fiber reinforced polyester corrugated structural plastics panels; CS210-57, melamine dinnerware (alpha-cellulose-filled) for household use; CS209-57, vinyl chloride plastics garden hose; CS207-57, rigid polyvinyl chloride pipe; CS206-57, solvent-welded (SWP size) cellulose acetate-butyrate pipe; and CS197-57, flexible polyethylene plastic pipe. Progress on the preparation of a commercial standard for polyethylene film was reported (686). Many other commercial standards are in various stages of preparation by S.P.I. committees working together with the National Bureau of Standards and the Commodity Standards Div. of the Department of Commerce.

Technical Committee 61 on Plastics of the International Standardization Organization (ISO/TC 61) met at the Burgenstock, Switzerland in July and approved 6 Draft ISO Proposals and 6 Draft ISO Recommendations, bringing the total approved Draft ISO Recommendations to 24. The new draft recommendations describe methods of test for Charpy and Izod impact strength, incandescence resistance, thermal stability of polyvinyl chloride compounds by Congo Red and discoloration methods, and bleeding of colorants from plastics. The draft proposals relate to the determination of tensile properties of plastics and melt flow index of polyethylene, recommended practices for compression and injection molding of test specimens of thermoplastics and compression molding of specimens of thermosetting materials, and standard atmospheres for conditioning and testing plastics (2). The next meeting of ISO/TC 61 will be held in Washington in November 1958.

Technical Committee 15 on Electrical Insulating Materials of the International Electrotechnical Commission (IEC/TC 15) has approved a standard for determining volume and surface resistivity, is circulating draft proposals for insulation resistance and tracking, and has other test methods for electrical properties of plastics in preparation (687). The committee is undertaking the compilation of design engineering data on 40 groups of insulating materials in a comprehensive encyclopedia of electrical insulation (688).



Electron micrograph of Dow Q-936.1, molded against a 15,000 lines/in. grating. (Ref. 657)

A.S.T.M. Committee D-20 on Plastics adopted 6 new tentative standards (689). These included specifications for extruded cellulose acetate butyrate pipe (D 1502-57T) and tetrafluoroethylene resin molding and extrusion materials (D 1457-56T), methods of test for transverse load of corrugated reinforced plastic panels (D 1502-57 T), orientation stress release of plastic sheeting (D 1504-57 T), and density of plastics by the density-gradient technique (D 1505-57T), and a recommended practice for resistance of plastics to artificial weathering using fluorescent light and a fog chamber (D 1501-57T).

A.S.T.M. Committee D-9 on Adhesives adopted the folowing three new tentative methods (690): amylaceous matter in adhesives (D 1488-57T); nonvolatile content of aqueous adhesives (D 1489-57T); and nonvolatile content of urea-formaldehyde resin adhesives (D 1490-57T). A.S.T.M. Committee C-3 on Chemical-Resistant Mortars (691) adopted a tentative specification for resin-type chemical-resistant mortars (C 395-57T) and a recommended practice for use of resin-type chemical-resistant mortar (C 399-57T). A.S.T.M. Committee C-19 on Structural Sandwich Constructions (692) approved tentative methods of test for flatwise flexure strength of sandwich construction (C 393-57T) and shear fatigue of sandwich core materials (C-394-57T).

The British Standards Institution issued new standards for flexible polyvinyl chloride sheeting (313) and crash helmets (693). Insignia of the S. P. I. Plastic Pipe Research Council and the National Sanitation Foundation are used to identify plastic pipe that has been approved for the transmission of drinking water (694). Factors involved in the selection of brand names for plastics were discussed (695).

References

1. "World trade in plastics," by E. Gansmuller and R. W. Crawford, Modern Plastics *35*, 101-109, 230, 232, 234, 237, 239 (Oct. 1957).

2. "International plastics meeting," Modern Plastics *35*, 129, 271, 272, 275, 276 (Oct. 1957).

3. "India: trend toward self-sufficiency," by A. H. Srikanta Aiyar, Modern Plastics *34*, 120-123 (Jan. 1957).

4. "Giant molecules," by H. F. Mark, Scientific American *197*, 81-89 (Sept. 1957).

5. "How giant molecules are measured," by P. J. W. Debye, Scientific American *197*, 90-97 (Sept. 1957).

6. "How giant molecules are made," by G. Natta, Scientific American *197*, 98-104 (Sept. 1957).

7. "The mechanical properties of polymers," by A. V. Tobolsky, Scientific American *197*, 121-126, 128, 133, 134 (Sept. 1957).

8. "Polyethylene," by G. Oster, Scientific American *197*, 139, 140, 145, 146, 148-150, 152 (Sept. 1957).

9. "Cellulose," by R. D. Preston, Scientific American *197*, 156-160, 162, 164-166, 168 (Sept. 1957).

10. "Proteins," by P. Doty, Scientific American *197*, 173-178, 180, 182, 184 (Sept. 1957).

11. "Nucleic acids," by F. H. C. Crick,

(*To page* 234)

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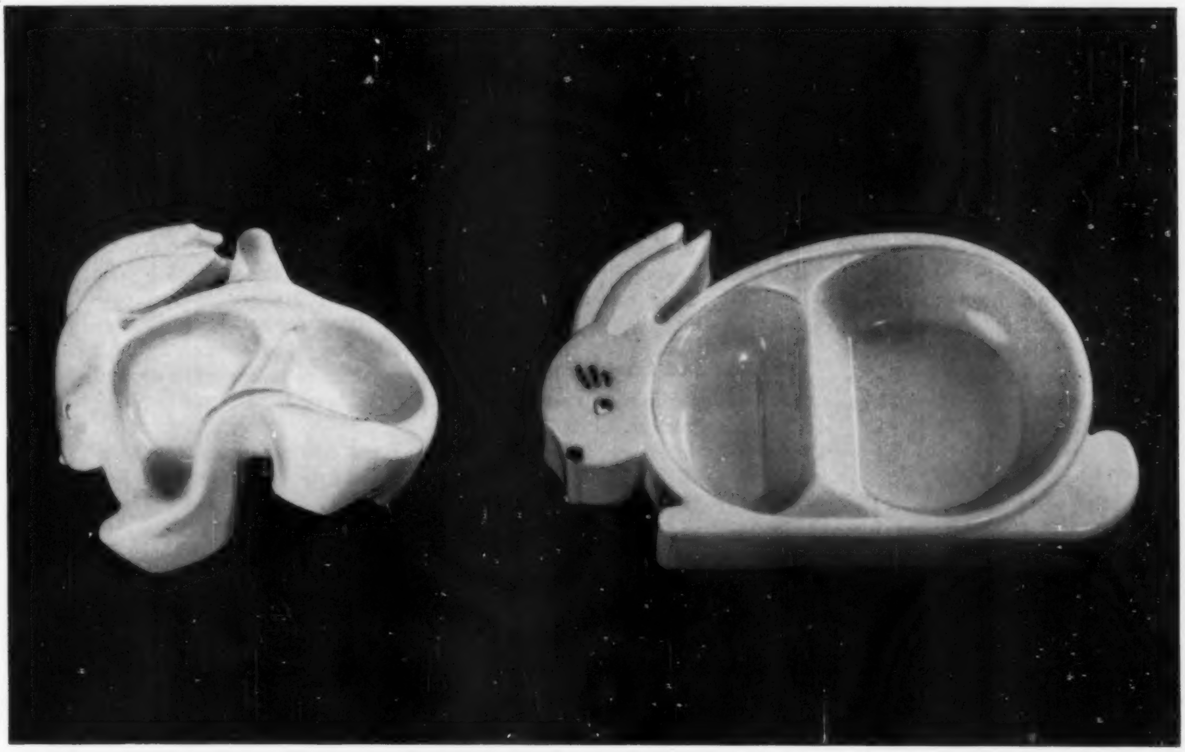

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Plastics Digest*

Abstracts from the world's literature of interest to those who make or use plastics or plastics products. For complete articles, send requests direct to publishers. List of addresses is at the end of Plastics Digest.

General

Great Britain D.S.I.R. chemistry research 1956, pp. 43, 45-55. A review of the work during 1956 in the Chemical Research Laboratory in England includes, among others, items on arsenic acid resins, new polymers containing arsenic and phosphorus, structure of polymers, permeability of polymer films, fractionation of polymers, and determination of molecular weight. Obtainable from British Information Services, 45 Rockefeller Plaza, New York 20, N. Y.

Materials

Evaluation tests for epoxy casting systems. M. V. Goodyear and J. P. Hornburg. Elec. Mfg. *60,* 125-9 (Sept. 1957). "Heat endurance" tests were devised to provide qualitative simulated service evaluation of epoxy casting resin systems. The tests involve weight loss studies and measurement of electrical properties after exposure to elevated temperatures for 312 hours. Tests were conducted at 130, 150, 175, and 200° C. The endpoint of the test was established when the physical condition of the specimen deteriorated. Good correlation between the tests and production applications was predicted. The test method was found useful for screening raw materials for the resin systems, such as fillers, plasticizers, and hardeners. Comparisons are given between solid and liquid epoxy resins, reactive and nonreactive plasticizers, and filled and unfilled systems.

Saran-coated films. M. E. Kelly, Jr., S. F. Roth, and H. R. Bailey. Modern Packaging *30,* 151-56, 222-24 (June 1957). By adding a coating of as little as 0.1 mil of saran to base films of cellophane, polyethylene, and polyester, the packaging qualities of these films can be greatly improved. Saran coatings can provide reduced water vapor and gas permeability; improved flavor retention; oil, grease, and chemical resistance; abrasion resistance; clarity; gloss; and slip. They can also provide heat sealability.

Molding and fabricating

Lamination of vinyl film to metal. I. U. S. Practice. G. E. Wintermute. Brit. Plastics *30,* 289-92 (July 1957). The American process for bonding vinyl chloride plastic film to steel is described in detail. The metal is first treated by a phosphatizing or chromating solution and then goes through a five-stage wash cycle followed by drying. The adhesive is applied by roller-coating and the solvent evaporated by heating. The adhesive is activated by further heating and the vinyl chloride plastic sheeting applied with pressure rolls. The laminate is then cooled quickly. *II. New British method.* Ibid. *30,* 292 (July 1957). A vinyl chloride plastic film-metal laminate was developed which, for several uses, is claimed to be superior to the American product. Cups drawn from the British laminate can be immersed in boiling water for an hour or more without any failure of adhesion whereas in cups drawn from other laminates, considerable peeling of the plastics film occurred after only a few minutes.

Applications

Pouch packaging. Canadian Plastics *1957,* 58-60 (Aug.). Pouch packaging is growing because the cost of packaging is lower, the advantages of "see through" have an impact on the impulse buyer, and automation is more easily accomplished. The advantages, disadvantages, and some uses of the more common solid and laminated films are described. The need for even better films and the problems of stacking are currently impeding more rapid expansion. Recent and near-future developments include saran-coated polyethylene, heat-sealable polyesters, new laminates, modified polyethylene, and polypropylene.

Using plastics in plant propagation. G. Taloumis. Plants & Gardens *13,* 94-101 (Summer 1957). Methods are explained and illustrated for making a miniature greenhouse by using polyethylene film to make an enclosure around the conventional seed flat. The use of polyethylene film for rooting cutting, for wrapping air layerings, for weed control, and for a moisture retention wrap around potted plants is reviewed.

Surface coating compositions: A survey of recent inventions. Research and Ind. *2,* 145-50 (June 1957). Significant advances in protective and decorative coatings, particularly those which have been patented in India in recent years, are reviewed. 77 references.

Sprayed-on foam slices insulation costs. C. H. Chilton. Chem. Eng. *64,* 158, 160, 162 (Oct. 1957). Techniques of applying polyurethane foams for thermal insulation applications are described. Examples of coupled installations are given. A list of companies engaged in the formulation of ingredients for sprayed-on foams is compiled and a description of available equipment is given.

Isocyanate - resin - coated elastomeric insulation. H. G. Steffens. Elec. Mfg. *60,* 113-15 (Sept. 1957). An improved isocyanate resin-coated electrical insulation is described. The material has high abrasion resistance, adhesion to glass, oil and solvent resistance, and improved extensibility. Data for some mechanical properties are given. These films are more thermally stable than fully cross-

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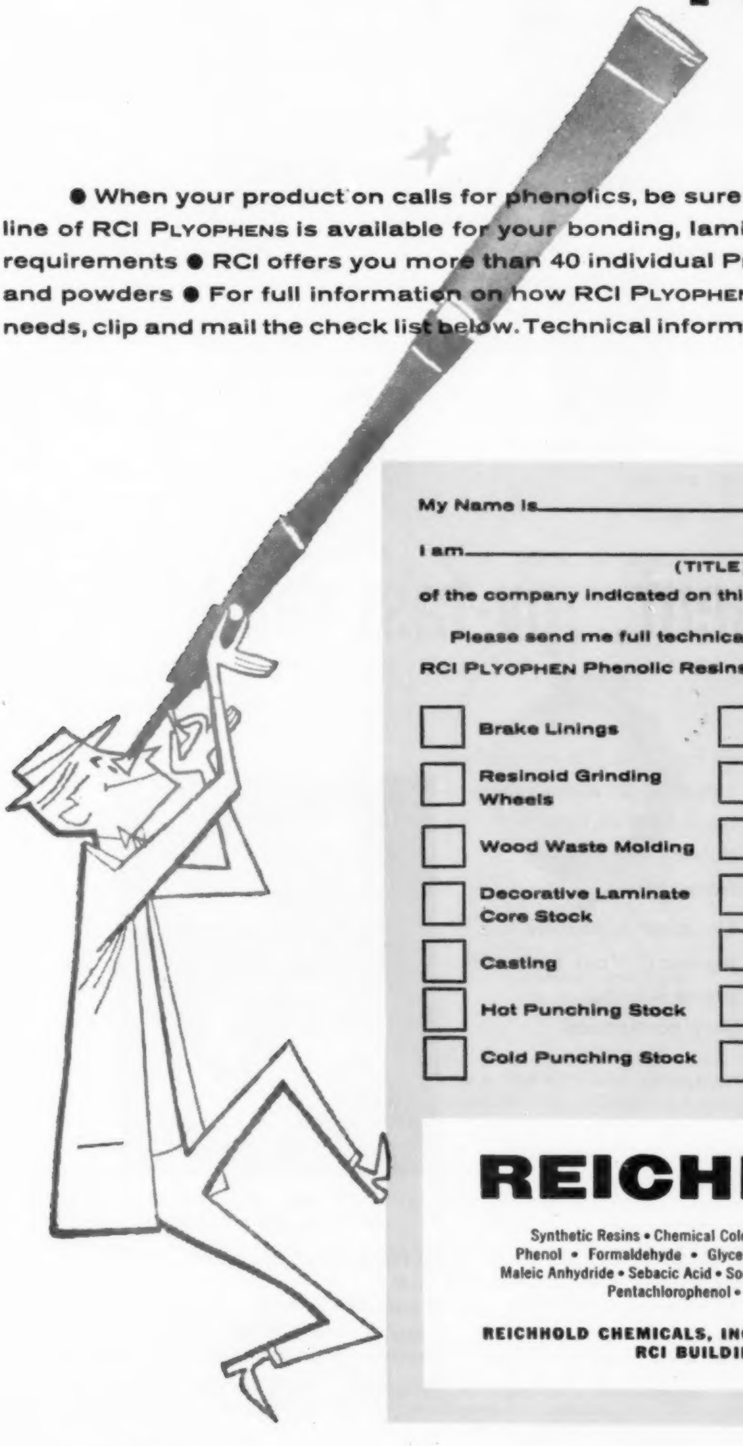

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linked isocyanate resin films. Comparative evaluation test data are presented for extensibility, resilience, and for aging tests at temperatures of 150 and 170° C.

Isocyanate-based (urethane) insulations. Products and applications. Insulation *3*, 40-43 (Sept. 1957). Isocyanate foams, potting compounds, elastomers, and adhesives are discussed. Producers of isocyanates and urethane insulations are listed.

Coatings

How cathodic protection affects paints and coatings. H. S. Preiser, F. E. Cook, and W. J. Francis. BuShips J. *6*, 15-18 (Sept. 1957). The effects of controlled potential on underwater coatings were determined by a series of tests. Results of these tests on vinyl, neoprene, epoxy, polyethylene, porcelain enamel, and other coatings are presented.

New poly resin emulsions A-1 for exterior masonry. E. I. Baker. The Plant *16*, 60-1 (Sept. 1957). The advantages of poly resin coatings for protecting bricks and cinder block against moisture and water erosion are reviewed.

Properties

Orientation in polyethylene terephthalate film. C. V. Liang and S. Krimm. J. Chem. Phys. *27*, 327-28 (July 1957). The benzene ring orientation in singly and doubly stretched polyethylene terephthalate films was determined by means of the effect of specimen tilting on the intensities of infrared bands. For stretching in one direction the chains are oriented in the direction of stretch and the plane of the benzene ring is essentially parallel to the stretching direction, but random in other directions. For film stretched in two directions mutually perpendicular the chains are not oriented, but the benzene rings are oriented with their planes essentially parallel to the film surface.

Nuclear magnetic relaxation in polytetrafluoroethylene and polyethylene. C. W. Wilson and G. E. Pake. J. Chem. Phys. *27*, 115-22 (July 1957). Nuclear magnetic

resonance studies of Teflon show that two phases exist, each with its own pair of relaxation times. The fraction of nuclei in each phase may be determined by decomposition of the complex resonance lines and complex saturation curves into normal curves. The possibility that the two phases are crystalline and amorphous regions is considered. Additional evidence is presented to support the suggestion. The data for polyethylene are less complete but also show two phases which show reasonable similarity to the expected values for crystalline and amorphous regions.

Non-destructive testing of plastic pipe. R. D. Brown. Canadian Plastics *1957,* 40-1, 44-6 (Apr.). The modulus of elasticity of reinforced plastic pipe may be determined by a non-destructive method. Changes observed in the resonant frequencies of the pipes may be used to calculate variations in the modulus. A relation between the modulus and the ultimate strength of the pipe is derived experimentally. Test results showing the effect of chemical aging and of large amplitude vibrations are presented. SR-4 strain gages were used for hydrostatic testing of the reinforced plastic pipe.

Gas and vapor permeability of plastic films and coated papers. III. The permeation of mixed gases and vapors. J. A. Meyer, C. Rogers, V. Stannett and M. Szwarc. Tappi *40,* 142-6 (1957). Measurements of the permeation of nitrogen, oxygen, and helium, pure and in mixtures with carbon dioxide, through polyethylene, Mylar, and nylon were made. The effects of water vapor on gas transmission and of gas on water vapor transmission were studied. There was no effect in the case of polyethylene or Mylar, but gas transmission through nylon increases with increasing relative humidity.

How Westvaco measures gloss on moving paper webs. J. Field. Paper Trade J. *141,* 42-4 (Mar. 25, 1957). A method is described for measuring and recording gloss

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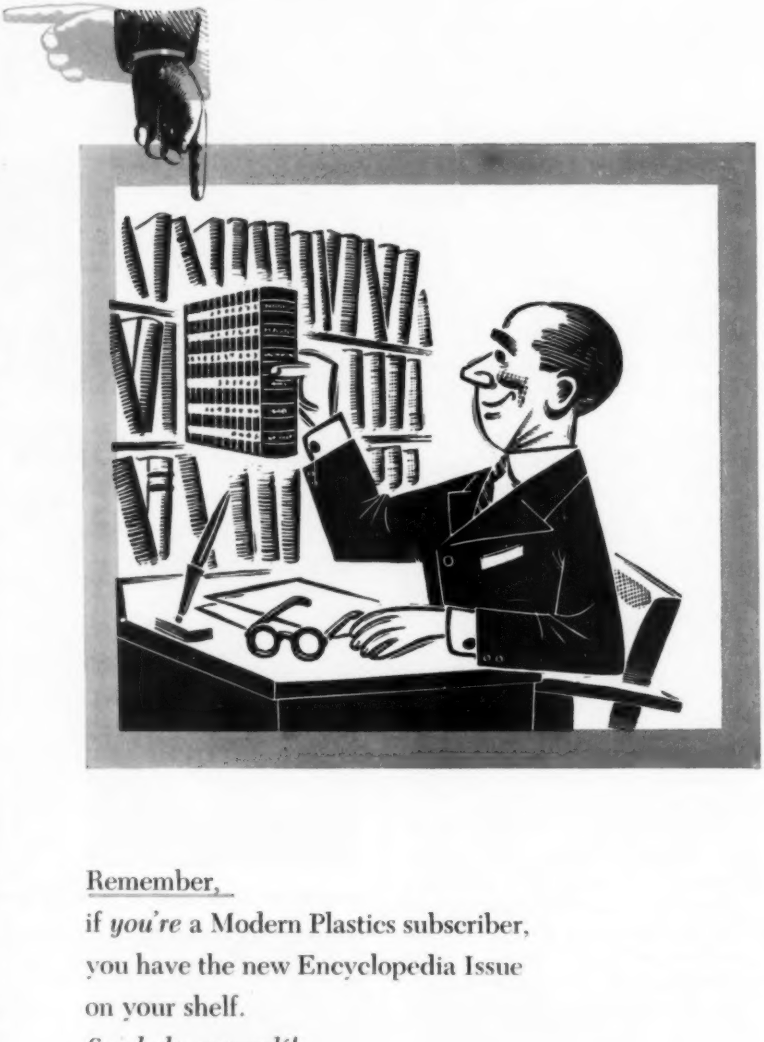

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continuously on both sides of a moving paper web. A cast aluminum casing with a lamp and lens system directs light to the sample at a 15° angle. A phototube and lens system also at a 15° angle measures the reflected light in conjunction with a Wheatstone bridge circuit with a continuous electronic balancing unit. Black carrarra glass is used as the standard since it reflects about 26% of the incident light and the best papers reflect about 25 per cent.

Testing

Automatic recording, gas/polymer-film permeameter. B. Rosen and J. H. Singleton. J. Polymer Sci. 25, 225-28 (July 1957). Automatic gas permeability equipment is described.

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Cyclization in gamma-ray-irradiated high-density polyethylene. M. Dole, D. C. Milner, and T. F. Williams. J. Am. Chem. Soc. 79, 4809 (Sept. 5, 1957). The formation of cyclic ring formations in Marlex-50 and a Ziegler-type polyethylene as a result of gamma radiation is demonstrated by the growth of a peak at a wavelength of 10.1 microns in the infrared region. Similar ring linkages are also indicated for the low density material.

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British Plastics: Iliffe and Sons, Ltd., Dorset House, Stamford St., London S. E. 1, England.

BuShips, Bureau of Ships Journal: Government Printing Office, Washington 25, D. C.

Canadian Plastics: Monetary Times Printing Co., Ltd., 341 Church St., Toronto 2, Ontario, Canada.

Chemical Engineering: McGraw-Hill Digest Publishing Co., Inc., 330 W. 42nd St., New York 36, N. Y.

Electrical Manufacturing: The Gage Publishing Co., 1250 Sixth Ave., New York, N. Y.

Insulation: Lake Publishing Co., 718 Western Ave., Lake Forest, Ill.

Journal of the American Chemical Society: American Chemical Society, 1155 Sixteenth St., N. W. Washington, D. C.

Journal of Chemical Physics: American Institute of Physics, 57 E. 55th St., New York 22, N. Y.

Journal of Polymer Science: Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y.

Modern Packaging: Modern Packaging Corp., 575 Madison Ave., New York 22, N. Y.

Paper Trade Journal: Lockwood Trade Journal Co., Inc., 15 W. 47th St., New York 36, N. Y.

Plants & Gardens: Brooklyn Botanic Garden, Brooklyn 25, N. Y.

Research and Industry: Council of Scientific & Industrial Research, Old Mill Rd., New Delhi 2, India.

Tappi: 155 E. 44th St., New York 17, N. Y.

Texture: Fairfax, Wilderness Rd., Chislehurst, Kent, England.

The Plant: St. Joseph, Michigan.

U.S. Plastics Patents

Copies of these patents are available from the U.S. Patent Office, Washington, D.C., at 25¢ each.

Resin. M. P. Seidel (to Westinghouse). U. S. 2,806,013, Sept. 10. Phenolic resin.

Copolymers. E. M. Beavers and T. E. Bockstahler (to Rohm and Haas). U. S. 2,806,014, Sept. 10. Copolymers of triallyl trimesate and unsaturated linear polymers.

Polymers. R. J. Kern (to Monsanto). U. S. 2,806,015, Sept. 10. Blends of polyvinyl butyrate and poly-*n*-propyl acrylate.

Polymerization. E. K. Drechsel (to American Cyanamid). U. S. 2,806,017, Sept. 10. Polymerization of cyclic carbamates.

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Copolymers. M. J. Scott and A. E. Peacock (to Monsanto). U. S. 2,806,020, Sept. 10. Vinyl acetate copolymers.

Cellular product. T. J. Dietz (to United States). U. S. 2,806,255, Sept. 17. Cellular butadiene-styrene.

Film. R. Smith-Johannsen (to S-J Chemical). U. S. 2,806,256, Sept. 17. Microporous film.

Vault. C. D. Crump. U. S. 2,806,278, Sept. 17. Molded plastic burial vault.

Foam structures. E. H. Merz (to Monsanto). U. S. 2,806,812, Sept. 17. Formed resin sheets having a resin foam attached thereto.

Copolymers. J. B. Ott (to Monsanto). U. S. 2,806,822, Sept. 17. Polyester-amide copolymers.

Reinforced structure. E. N. Squire (to Du Pont). U. S. 2,806,826, Sept. 17. Phenol-modified glass-fiber-reinforced amine-urea-formaldehyde composition.

Vinyl resin. D. E. Hardman (to Union Carbide). U. S. 2,806,828, Sept. 17. Plasticized vinyl resin.

Copolymers. G. Nischk and K. E. Muller (to Farbenfabriken Bayer). U. S. 2,806,834-5-6, Sept. 17. Copolymers of polyesters condensed with xylene-formaldehyde resins and diisocyanate-modified polyester resins.

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Polymers. C. E. Barnes, W. R. Nummy, and W. O. Ney, Jr. (to Arnold Hoffman). U. S. 2,806,841, Sept. 17. Polymers of alpha-piperidone.

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Ion exchange. K. Haagen (to Bayer). U. S. 2,807,594, Sept. 24. Phenolic ether anion exchange resins.

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Dental materials. H. Schnell and W. Becker (to Bayer). U. S. 2,807,602, Sept. 24. Dental materials containing butadiene copolymers.

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Polymers. J. Lincoln (to British Celanese). U. S. 2,807,606, Sept. 24. Fiber-forming polyesters and polyamides.

Mold. L. M. Dorman (to Talon). U. S. 2,807,970, Oct. 1. Die insert for molding slide fastener stringers.

Foam resins. H. A. Walter (to Monsanto). U. S. 2,808,379, Oct. 1. Foaming resins with furan adduct foaming agents.

Dextrin composition. R. A. Stone (to Paisley Products). U. S. 2,808,381, Oct. 1. Resin-dextrin compositions.

Resins. H. Fikentscher and H. Wilhelm (to Badische Anilin). U. S. 2,808,383, Oct. 1. Water-soluble methylol compounds of copolymers of a N-vinyl lactam and an acrylic acid.

Dispersions. K. Gerbel and E. Huss (to Bayer). U. S. 2,808,384, Oct. 1. Polychlorotrifluoroethylene dispersions.

Fibers. J. R. Caldwell (to Eastman Kodak). U. S. 2,808,385, Oct. 1. Fibers from polyacrylonitrile and bentonite.

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Polymers. C. E. Parks and G. L. Wheelock (to B. F. Goodrich). U. S. 2,808,387, Oct. 1. Shock-resistant polyvinyl halide compositions.

Hydrosols. R. J. Hellmann (to Eastman Kodak). U. S. 2,808,388, Oct. 1. Hydrosols of polyacrylic esters.

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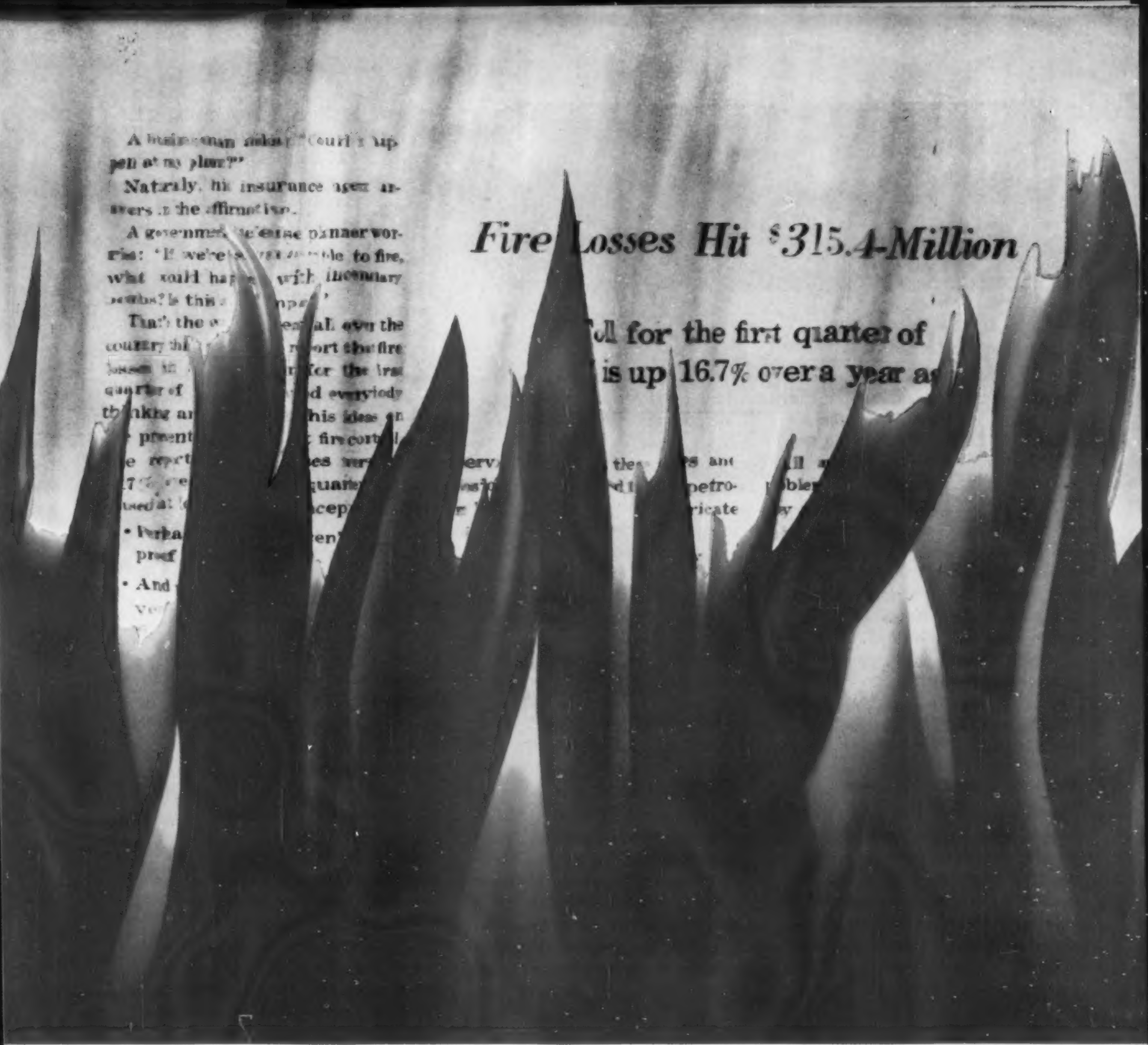

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Extrusion laminator

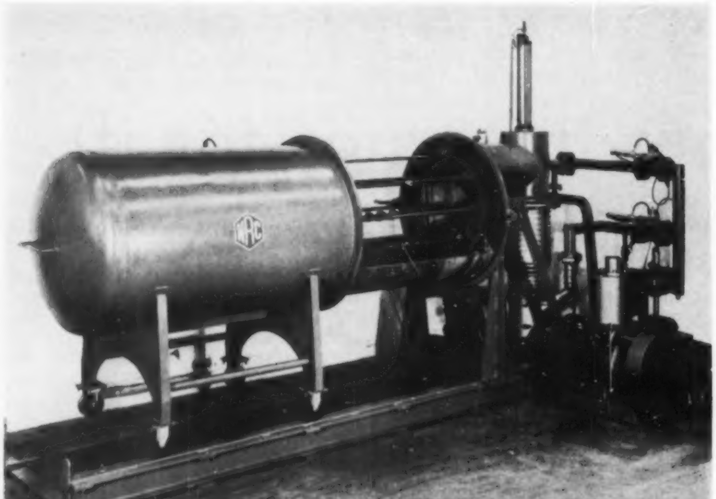
Model PL-600 is intended for extrusion-coating polyethylene film to various substrates, e.g., cellophane, Mylar, foils, and papers. Widths up to 100 in. can be accommodated with speeds to 1000 ft./min. The PL-600, in comparison with previous models, offers better accessibility to controls, openness of construction, easier roll removal. Films to be joined are pressed between a 10-in.-diameter silicone rubber roll and a chilled metal roll whose diameter may be 18, 20, or 24 inches. Rubber covered roll can also be cooled. *The Black-Clawson Co., Dilts Div., Fulton, N. Y.*

Vacuum metallizing unit

The NRC Model 3143 is a medium-capacity coater intended for smaller production volumes, sample orders, etc. Jig rods and work holding fixtures are interchangeable with those of NRC's larger units, facilitating subsequent expansion. Coating chamber is 5 ft. long, 42 in. in diameter, provides 139 sq. ft. of coating capacity per load. Pumping system consists of a rotary gas ballast mechanical pump and a 16-in. oil diffusion pump with necessary piping and valves. It will exhaust an empty (clean) chamber to working pressure in less than 10 min.; unit can process three to five full batches per hour. Necessary controls and instruments are included. *NRC Equipment Corp., 160 Charlemont St., Newton Highlands 61, Mass.*

Potentiometer recorder

The Marksman strip-chart recorder uses printed circuits and transistors in its amplifier, has no vacuum tubes. Features include automatic standardization, thermocouple-break protection, cold-junction compensation, adjustable chart speeds without changing gears, and battery condition indicator. It is available with a full selection of scale ranges and speeds, can record any quantity that can be transformed into an e.m.f. Fits into any standard 19-in. relay rack. *West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.*



NRC vacuum metallizing unit for smaller production volumes has jigs that are interchangeable with those of NRC's larger units

Open-end tumbler

This tumbling machine, which resembles a small cement mixer, consists of a rotating, octagonally shaped, open-ended barrel, so mounted that it can be tilted to any angle upward from the horizontal and locked there. The all-metal barrel is water-tight and can be lined with wood or polyvinyl chloride; thus, either wet or dry tumbling can be performed. Barrel is 25 in. deep, about 21 in. across. Frame requires 3 sq. ft. of floor area. *H. W. Kramer Co., Inc., 120-30 Jamaica Ave., Richmond Hill 18, N. Y.*

Infrared sintering ovens for TFE

Heating cycles for sintering TFE resin (Teflon) have been greatly shortened by using quartz infrared lamps as heat sources in specially designed ovens. Temperatures of 700 to 740° F. can be attained in about 40 to 80 sec., depending on the weight and shape of the article being heated. Lamp rating is 100 w./in. of lamp length. Oven can be tailored to shape and size of item to be sintered, and can be either batch type or open-ended continuous type. *The Fostoria Pressed Steel Corp., 1952 Bradner St., Fostoria, Ohio.*

Self-contained irradiator

The Hotrodder, an irradiation unit useful in treating plastics, polymerization, etc., is completely self contained and is so safe that it can be used in an office or laboratory. It requires no specially shielded room, no auxiliary monitoring or alarm systems, no remote handling equipment. Made of stainless steel plate filled with void-free lead, the Hotrodder can safely hold up to 25,000 curies of Co-60. Samples up to 10 in. long and 10 in. in diameter

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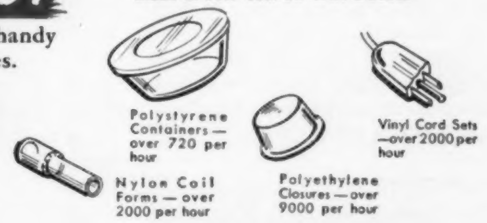

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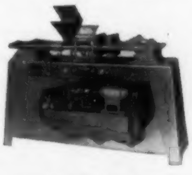

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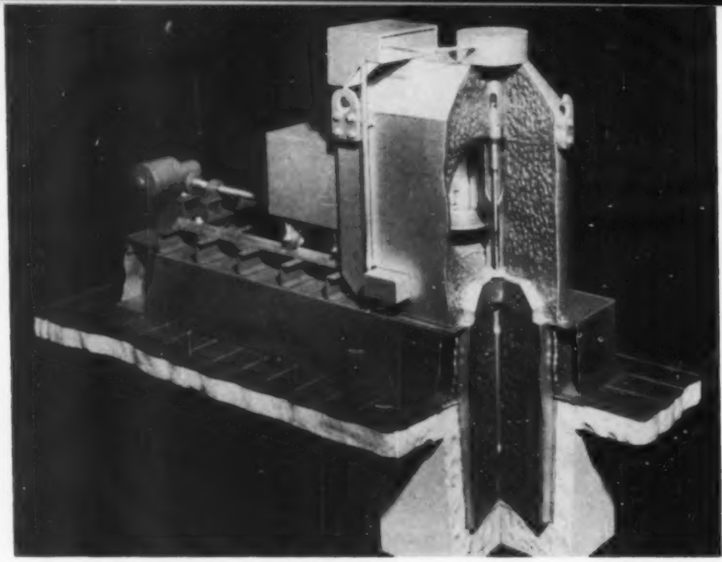


Nuclear Systems Hotrodder, a self-contained irradiator, is claimed to be safe enough to use in office or laboratory

can be irradiated. The chamber is also provided with tubular access allowing the sample to be connected to outside water, gas, or electric lines during irradiation (Co-60 emits only gamma rays; this type of radiation does not induce radio-activity in material which is exposed to it). *Nuclear Systems, Div. of The Budd Co., 2950 Roberts Ave., Philadelphia 32, Pa.*

Foam cuber

The Rudmar Cutter will cut crisp-edge rectangular shapes from polyurethane foam slabs up to 24 in. square and from 1 to 3 in. thick. (A larger model that will handle 36- by 36-in. slabs is being planned.) The grooves in the platens, which hold the slab, allow crisscrossing knives to dice the foam. Two-inch cubes were produced at the rate of 16,000 per hour. *Falls Engineering and Machine Co., 1734 Front St., Cuyahoga Falls, Ohio.*

Laboratory mixers

The Z-blade Atlantic laboratory mixer has a one-pint capacity and can efficiently work batches as small as 5 cu. in. (80 cu.cm.). Particular attention has been paid to prevention of grease leakage from bearings, or intrusion of working medium into bearings. The mixer can be quickly taken down for cleaning, the mixing chamber temperature can be controlled, and a partial vacuum or a blanket of inert gas can be maintained during the working of the material. *Atlantic Research Corp., Alexandria, Va.*

The Marion Laboratory Mixer is quite different from the above. It is a horizontal ribbon blender having inside dimensions 24 by 12 by 16 inches, and a capacity of 2 cu. feet. Available either in mild or stainless steels, the blender is powered by a ¾- or 1-hp., gear-head motor. The metal cover is gasketed with sponge rubber. *Rapids Machinery Co., Marion, Iowa.*

Mold-water circulator

A new model IMS constant-temperature circulator for injection molds has a ¼-hp. pump delivering 20 gal./min. against 10 p.s.i. (previous unit had ⅙-hp. pump). The circular also has a temperature-sensing element that controls the mixing of hot and cold water to provide the proper mold temperature. Mounted on casters, it takes up 2.4 sq. ft. of floor space. *Injection Molders Supply Co., 3514 Lee Rd., Cleveland 20, Ohio.*

Clamp for gluing decorative laminate edgings

Many decorators prefer worktops surfaced with hard plastic laminates to be edged with the same material. For good adhesion of the thin edge strips to the plywood, the edges must be properly clamped while the adhesive sets. Black Bros. offer a clamp for this work that consists of four heavy metal jaws arranged in an overlapping rectangle. The jaws are preliminarily adjusted to the work size by handwheels, then final pressure is applied indirectly by air cylinders. For banding curved edges, wood forms are used in conjunction with the clamps. Flexible, stainless steel strip heaters can be clamped between jaws and edgings to cure thermosetting adhesives. *Black Bros. Co., Inc., Mendota, Ill.*

Hopper loader

The newly redesigned Rainco vacuum loader will load molding powders at rates up to 1200 lb./hr., and will handle dry-colored powders without dusting. Automatic clearing of the filter after each loading permits the user to load fine powders in this unit. For corrosive service, it can be had in stainless steel. *The Rainville Co., 224 Seventh St., Garden City, N. Y.*

Slide rail folder for blister packages

Standard blister packs cannot be conveniently reclosed, once opened. The Tronomatic 180° flange bender provides a slide rail or slot for a sliding top on a formed blister package. This makes it possible for the prospective customer to manually inspect or try on the merchandise without damaging the package. Strings of blisters up to 30 in. long are processed in units, two operations requiring about 6 sec. each providing flanges along both sides. Blisters up to 2.5 in. deep, 12 in. wide and 30 in. long can be flanged. Folds can be modified so that any desired thickness of board can be slid into the slots. Folds grip the board snugly. *Tronomatic Machine Mfg. Corp., 1881 Park Ave., New York 35, N.Y.*

Cast-in heaters

While the principle of "cast-in" heaters is not new, Adaptatherm heaters incorporate a useful departure from previously known types. An electrical insulation has been developed that is flexible, is a good conductor of heat, and is able to withstand aluminum casting temperatures. Because of its flexibility, resistance wire insu-

lated with this material can be easily laid out in any desired configuration prior to casting. The insulation gives but does not break as the wire expands and contracts during cycling, thus eliminating burn-outs, hot spots, and shorts. Heaters can be cast to any castable shape with practically any desired heat input. *H. W. Tuttle & Co., Adrian, Mich.*

Non-loading abrasive paper

One of the problems in finishing plastics is their tendency to clog or "load" sandpapers and emery cloths. A new "No-Load" finishing paper has been coated to discourage adhesion of soft particles. Any build-up between the grits is easily discharged by slapping the paper. The "No-Load" paper can be used wet and holds its silicon carbide abrasive even when being used on sharp edges. Available in many grit numbers. *Armour and Co., 31st St. Auxiliaries, Chicago 9, Ill.*

Portable electronic sealer

Designed to handle a variety of small operations, the Kabar portable sealer has power enough to seal an 8- by 1/16-in. area in 12-gage vinyl. It operates at about 30 mc., and is internally shielded, requiring no additional shielding if straight bar dies are used. Built-in, self-resetting timer controls cycle; pressure is applied by hand. Air-cylinder or foot-lever operation is available at extra cost. To install, just plug it into any 115-v. outlet. *Kabar Mfg. Corp., 1907 White Plains Rd., New York 62, N.Y.*

Cycle timers

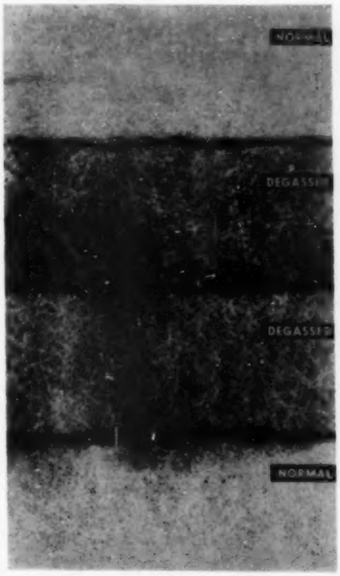
A line of repeat cycle timers suitable for control of plastics processing operations is offered in both relay-operated and electronically operated types and in several ranges and sensitivities. *G. C. Wilson & Co., P.O. Box 5525, Huntington, W.Va.*

Multiple presses

In addition to a single-platen model of 50-ton capacity, Allied offers this press ganged in twos, threes, or fours. The multiple-platen presses have a single housing, so one operator can control all the rams. These presses all derive their power from existing compressed-air lines and can develop up to 5000 p.s.i. on their 13- by 13-in. platens, which come either heated (to 550° F.) or not. Maximum daylight opening is 13 inches. Various modifications, including higher capacities and temperatures, are available. *Allied Engineering and Production Corp., 2421 Blanding Ave., Alameda, Calif.*

Reinforced molding degasser

Air bubbles in polyester resins are responsible for voids, pits, and weaknesses resulting therefrom in polyester laminates. Degassing the resin before pouring not only eliminates part of the gas that causes the bubbles but also gives the resin full capacity to dissolve bubbles trapped during impregnation of the glass cloth or mat. A vacuum degassing kettle having a working capacity of 60 gal., can expose the resin to pressures as low as 50 mm. Hg, thus encouraging the release of dissolved gases. The kettle comes instrumented and equipped with a cyclone trap, is jacketed for heating or cooling, has a pump driven by a 1-hp. explosion-proof motor. A dual-impeller agitator is optional. *Hull Corp., Hatboro, Pa.*



Normal panels are opaque with tiny bubbles. Hull degasser gives clear moldings

Books & Booklets

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

"1958 Modern Packaging Encyclopedia Issue"

Published as 13th issue Modern Packaging Magazine in November 1957 by Packaging Catalog Corp., 575 Madison Ave., New York 22, N. Y. 817 pages.

This comprehensive reference book for the packaging industry, dealing with all kinds of materials and all types of packages, has been thoroughly updated. It includes 16 new articles on production and machinery as well as an outstanding feature, "Total economy—a cost method for mechanical packaging systems," which is must reading for everyone concerned with unit package costs. The greatly expanded and updated section on plastics containers is designed to keep packagers abreast of the fast moving developments in this field and includes several standard charts: "Cost table—plastics for molded containers"; "Characteristics of molded plastics"; "Sheet plastics for thermoforming"; and "Characteristics of sheet plastics." The Buyers' Directory section has been thoroughly revised to serve as a dependable guide to suppliers and producers of machinery, materials, and containers.

"C.R.C. Standard Mathematical Tables, 11th Edition"

Edited by C. D. Hodgman and S. M. Selby

Published in 1957 by Chemical Rubber Publishing Co., 2310 Superior Ave., N.E., Cleveland, Ohio. 483 pages. Price: $3.00.

The latest edition of this very handy collection (which is included in the Handbook of Chemistry and Physics) is almost 10% larger than the tenth edition. The sections pertaining to differential equations have been enlarged to include more on Fourier series and Leibnitz D operators, a table of natural trigonometric functions of angles in decimal multiples of π radians has been added, and a procedure for extending the table of factors and primes has been included. The readable format and clear printing of the tenth edition have been preserved in the new edition.

"Chemical Engineering Catalog, 1958"

Published in 1957 by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. 1960 pages. No charge in the United States and Canada if volume is returned when new edition is published.

The 42nd annual edition of this completely indexed reference volume covering the chemical processing industries offers a wealth of descriptive and illustrative material on equipment available from more than 500 manufacturers.

Injection molding machine. Complete specifications and standard optional equipment for Model 200-H-6/8, a 6/8-oz. plastics injection molding machine. 6 pages. *The Hydraulic Press Mfg. Co., a Div. of Koehring Co., Mt. Gilead, Ohio.*

Polyurethane elastomer. Physical properties and characteristics of Genthane-S, polyurethane elastomer, under various conditions. Fillers, plasticizers, processing, and curing are discussed, and test results are shown in a series of graphs and charts. 14 pages. *Chemical Div., The General Tire & Rubber Co., Akron, Ohio.*

Molding compounds. New products, uses, and markets for Plaskon urea, melamine, and alkyd molding compounds, and Plaskon nylon molding and extrusion compounds. Bulletin P-95. 4 pages. *Barrett Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.*

AEC reports. Price list of more than 4500 Atomic Energy Commission unclassified reports including documents acquired since Dec. 31, 1956. Price List No. 28. *Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D. C.*

Polyethylene film. Tips on methods for cutting, taping, stitching, sealing, grommeting, and repairing polyethylene film on the farm and in the home. Booklet D-502, "Durethene Polyethylene Film." 24 pages. *Chemical Div., Koppers Co., Inc., 1450 Koppers Bldg., Pittsburgh 19, Pa.*

Trifunctional alcohol. Properties, shipping information, solubilities, performance data, and applications of 1,2,6-hexanetriol, a stable, high-boiling liquid that offers advantages in many applications where glycerol is now used. Bulletin F-40,066. 8 pages. *Union Carbide Chemicals Co., 30 E. 42nd St., New York 17, N. Y.*

Polymeric plasticizer. Technical data report on polymeric plasticizer NP-10, together with a number of formulation suggestions involving the use of NP-10 and other plasticizers for such plastisol applications as cloth coating, slush molding, foamed plastisols, and clear film. Technical Data Report L-101. 6 pages. *Eastman Chemical Products, Inc., Kingsport, Tenn.*

Packaging and materials handling. Catalog of 118 reports in the field of packaging and materials handling, including German documents captured in World War II. CTR-72, "Packaging and Materials Handling, 1941-57." Price: 10¢. *Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

Infrared. Bibliography includes material concerned with the scientific aspects of infrared radiation and its effects, and all technical applications with the exception of its use in industrial

heating and drying processes. Volume PB 121998, "Infrared: A Library of Congress Bibliography, Part II." Price: $3.00. 156 pages. *Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D. C.*

Primary amyl acetate. Properties, specifications, applications, and data related to water extractions and to performance in lacquers of primary amyl acetate, the high-boiling ester of an oxo-process alcohol. Bulletin F-8911. 8 pages. *Union Carbide Chemicals Co., 30 E. 42nd St., New York 17, N. Y.*

Industrial chemicals. Sales data sheets for company's coal-derived industrial chemicals gives specifications, properties, and commercial information on one side, and on the other, a logarithmic graph which charts production and sales of the particular product described. *Industrial Chemicals Div., Pittsburgh Coke & Chemical Co., Pittsburgh, Pa.*

Chemical progress. A panoramic picture of the company's basic organic and inorganic chemicals, their principal applications, and their production. "The Story of Diamond Chemicals—Chemicals You Live By," 5th ed., revised and enlarged. 32 pages. *Diamond Alkali Co., 300 Union Commerce Bldg., Cleveland 14, Ohio.*

"New Tools for the Plastics Industry" explains how Nicoform electroformed cavities are made, new design possibilities for molded phenolic closures, and lists applications which previously could not be molded in plastics. *Electromold Corp., 290 Enterprise Ave., Trenton, N. J.*

"Plastics Deflashing Picturegram" illustrates and describes how four plastics manufacturers have solved their deflashing problems with savings in time and money. 4 pages. *Wheelabrator Corp., 1254 S. Byrkit, Mishawaka, Ind.*

Hydrogen peroxide. Review and bibliography of the application of hydrogen peroxide for epoxidation and hydroxylation of olefins, and a review of the many present and potential uses of the resulting products. 24 pages. *Solvay Process Div., Allied Chemical & Dye Corp., 61 Broadway, New York 6, N. Y.*

Chlorinated paraffin. Compatability, hardness, low temperature flexibility, and 100% modulus are given for two commercial chlorinated paraffins, Chlorowax 40 and Chlorowax LV. Bulletin P1-0657-2, "Evaluation of Chlorinated Paraffin as a Secondary Plasticizer for Polyvinyl Chloride." 15 pages. *Chlorinated Products Div., Diamond Alkali Co., 300 Union Commerce Bldg., Cleveland 14, Ohio.*

Polyvinyl alcohols. Specifications, solutions, and compounding; properties; and industrial uses of Lemol polyvinyl alcohols. Bulletin M13-T. 24 pages. *Chemical Div., The Borden Co., 350 Madison Ave., New York 17, N. Y.*

Lighting system. Illustrations of how it is now possible to use a new package lighting system—Sylva-Lume, winner of the "Best of Show" award at the National Electrical Industries Show last April—to create luminous ceilings to suit any interior. 6 pages. *Sylvania Electric Products Inc., Wheeling, W. Va.*

Vinyl acetate monomer. Operating procedures, physical properties, specifications, shipping data, applications, polymerization techniques, analytical procedures, and physical properties of Niacet, an economical vinyl acetate monomer that forms polymers having adhesive and film forming properties. Bulletin F-7575. 16 pages. *Union Carbide Chemicals Co., 30 E. 42nd St., New York 17, N.Y.*

Patterns. Examples of the company's work in unusual and intricate wood and metal patterns made to exact specifications. 4 pages. *Linden Pattern Corp., 1807 W. Elizabeth Ave., Linden, N.J.*

Product catalog. Listing and prices of electrical and mechanical products including phenolic wire connectors and ethyl cellulose, saran, and nylon plastic clamps. Catalog 12-B. 41 pages. *Holub Industries, Inc., Sycamore, Ill.*

Low-temperature plasticizer. Properties and performance advantages of Plastolein 9078, a low-temperature plasticizer in the adipate price range. Bulletin 401. 3 pages. *Emery Industries, Inc., Carew Tower, Cincinnati 2, Ohio.*

Plasticizer. Properties, characteristics, and results of immersion tests of ODN, a plasticizer used in the compounding of acrylonitrile copolymers and various vinyl resins. Bulletin 06-73-3-8-57. 8 pages. *Harwick Standard Chemical Co., 60 S. Seiberling St., Akron 5, Ohio.*

"Progress Through Research" reviews the company's research and development activities in welding metallurgy, chemistry, and engineering. 28 pages. *Air Reduction Co., Inc., 150 E. 42nd St., New York 17, N.Y.*

Starch fractions. Physical and chemical properties and applications of Superlose amylose and Ramalin amylopectin, both separate fractions of starch commercially available for the first time. 14 pages. *Colloid Dept., Stein Hall & Co., Inc., 285 Madison Ave., New York 17, N.Y.*

"Chipboard Manufacture" presents a schematic diagram of a modern chipboard installation and illustrates and describes a number of chipboard plants. 12 pages. *Karlton Machinery Corp., 210 E. Ohio St., Chicago 11, Ill.*

Cadmopone colors. Catalog sheet describes new type of reduced cadmium pigment that is lighter and fluffier for easier dispersion, highly resistant to heat, light, acids, and alkalies, and gives permanent, non-bleeding, and fade-resistant colors for all plastics. *Color Div., Ferro Corp., 4150 E. 56th St., Cleveland 5, Ohio.*

Neopentyl glycol. Various applications and derivatives of neopentyl glycol (2,2- dimethyl-1, 3-propanediol) in polymeric plasticizers, polyurethane foams, un-

saturated polyester resins, monoesters and alkyd resins. 5 pages. *Eastman Chemical Products, Inc., Kingsport, Tenn.*

Liquid buffing. Installation of the Liquimatic system of buffing, explained in terms of its three elements—pump, master control, and spray guns. Bulletin LC-100. 4 pages. *Hanson-Van Winkle-Munning Co., Grand Rapids, Mich.*

Particle board. Desription of Wynnewood particle board available in three densities to meet all applications from flooring, furniture, walls, and ceilings, to corestock. 4 pages. *Wynnewood Products Co., P. O. Box 1088, Jacksonville, Tex.*

Chemically-resistant hose. Information on Fluoroflex-T chemically-resistant, high- and medium-temperature hose and hose assemblies. 12 pages. *Resistoflex Corp., Roseland, N.J.*

PVC processing. "Fillers for PVC" and "Plasticizers and Plasticization," both 8 pages, are available from *British Geon, Ltd., Devonshire House, Piccadilly, London W.I., England.*

Displays. Catalog of displays including reproductions of glazed mosaic tile created in vacuum formed plastics. 16 pages. *W. L. Stensgaard & Associates, Inc., 346 N. Justine St., Chicago 7, Ill.*

Polyethylene. The following Marlex 50 polyethylene bulletins are available: "#1. Extruded Sheet." 4 pages; "#2. Injection Molding." 8 pages; "#3. Thermoforming." 4 pages; and "#4. Marlex Types." 4 pages. *Phillips Chemical Co., Bartlesville, Okla.*

Fasteners. Data on Speed Nuts for threaded parts; non-threaded parts; molding, seal strips, tubing, etc.; and other uses such as harness clamps, latches, etc. 16 pages. *Tinnerman Products, Inc., P. O. Box 6688, Cleveland 1, Ohio.*

Polyvinylpyrolidone. Physical and chemical properties, toxicity data, industrial uses, and available commercial types of high molecular polymer PVP. References are included. 48 pages. *Antara Chemicals, General Aniline and Film Corp., 435 Hudson St., New York 14, N.Y.*

Drum maintenance. General specifications and operational methods of Portco drum reconditioners, and Portco drum rinser model 2K. Bulletins 85 and 86, respectively. 4 pages each. *The Portland Co., Portland 6, Me.*

Blacks. Properties and applications of carbon blacks, bone blacks, iron oxide colors, and black dispersions. 4 pages. *Columbian Carbon Co., 380 Madison Ave., New York 17, N.Y.*

ABS polymer blend. Safe working pressures, size and weight, flow vs. head loss for water, and chemical resistance of semi-rigid Kralastic pipe. 8 pages. *Republic Steel Corp., Cleveland 1, Ohio.*

Micro projector. Applications, advantages, and price list of the vertical Scherr micro projector for inspection and measurement of precision parts. 8 pages. Catalog P-1500. *George Scherr Co., Inc., 200 Lafayette St., New York 12, N.Y.*

S.P.I. report. Domestic production of plastics in 1956 reached a new high, with an estimated value of more than $2 billion, according to the Annual Report (fiscal year June 1, 1956 to May 31, 1957) of the S.P.I. 33 pages. *The Society of the Plastics Industry, Inc., 250 Park Ave., New York 17, N.Y.*

PVC suspension process. Case histories describing the suspension process for the manufacture of PVC resins developed by the company. A flow sheet of the process is included. 8 pages. *Scientific Design Co., Inc., 2 Park Ave., New York 16, N.Y.*

Silicas. New silica gels, hydro gels and other synthetic silicas, and the company's new continuous process which is capable of economically producing either small or large quantities of standard or special compounds. 4 pages. *American Industrial Chemical Co., Div. of Amerace Corp., Cooper Park, Butler, N.J.*

Plastics

Production and sales in 1000 lb.*
for August and September 1957

Materials	*Total p'd'n first 9 mos. of 1957‡*	*Total sales first 9 mos. of 1957‡*
Cellulose plastics:[a]		
Cellulose acetate and mixed ester		
Sheet, under 0.003 gage	14,538	13,917
Sheets, 0.003 gage and over	13,404	13,026
All other sheets, rods, tubes	5,304	5,154
Molding, extrusion materials	68,485	67,017
Nitrocellulose sheets, rods, tubes	3,056	3,091
Other cellulose plastics	4,209	3,634
Phenolic and other tar-acid resins:		
Molding materials[a]	132,652	131,162
Bonding and adhesive resins for:		
Laminating (except plywood)	45,577	35,275
Coated and bonded abrasives	12,562	12,383
Thermal insulation	39,639	39,261
Plywood	35,072	26,601
All other bonding uses	41,194	39,798
Protective-coating resins	22,455	19,068
Resins for all other uses	27,950	23,549
Urea and melamine resins:		
Textile-treating resins	26,083	25,651
Paper-treating resins	19,111	17,845
Bonding and adhesive resins for:		
Plywood	70,771	68,843
All other bonding and adhesive uses, including laminating	23,381	21,839
Protective-coating resins	26,778	20,414
Resins for all other uses, including molding	66,288	67,131
Styrene resins:		
Molding materials[a]	308,002	300,490
Protective-coating resins	61,135	59,385
Resins for all other uses	107,161	89,735
Vinyl resins, total[b]	617,662	562,590
Polyvinyl chloride and copolymer resins (50% or more polyvinyl chloride) for:		
Film (resin content)		70,021
Sheeting (resin content)		41,886
Molding and extrusion (resin content)		163,048
Textile and paper treating and coating (resin content)[c]		49,572
Flooring (resin content)		61,471
Protective coatings (resin content)		25,274
All other uses (resin content)		34,600
All other vinyl resins for:		
Adhesives (resin content)		31,655
All other uses (resin content)		85,087
Coumarone-indene and petroleum polymer resin	189,985	190,192
Polyester resins	69,943	63,907
Polyethylene resins	496,707	472,148
Miscellaneous:		
Molding materials[a, d]	35,306	35,344
Protective-coating resins[e]	9,900	4,885
Resins for all other uses[f]	99,300	90,803

*Dry basis designated unless otherwise specified. †Revised.
‡Partially estimated. ¶Includes friction materials.
[a]Includes fillers, plasticizers, and extenders. [b]Production statistics by uses are not representative, as end use may not be known at the time of manufacture. Therefore, only statistics on total production

Production

From statistics compiled by the U. S. Tariff Commission

August†		September‡	
Production	*Sales*	*Production*	*Sales*
1,600	1,562	1,716	1,742
1,570	1,511	1,693	1,579
410	413	777	681
7,200	7,739	9,098	8,575
318	300	281	292
511	465	495	457
†12,994	†15,719	14,669	14,471
† 3,552	4,234	5,225	4,193
1,328	1,371	1,336	1,533
5,243	5,216	4,411	4,639
3,859	2,931	4,167	3,169
† 4,637	† 4,848	4,752	5,202
2,257	2,178	2,653	2,257
3,440	2,316	2,846	2,378
2,702	2,839	2,649	2,686
1,864	1,950	1,868	1,897
† 8,273	† 7,634	8,665	8,643
3,339	2,808	2,928	2,887
2,639	2,050	2,921	2,370
7,419	7,435	7,376	7,747
35,030	33,291	37,485	36,669
6,566	6,145	6,661	6,651
11,489	9,731	11,011	10,286
72,263	63,916	72,238	65,258
	7,121		9,406
	4,941		4,987
	17,962		18,653
	6,884		6,542
	7,553		7,156
	2,515		2,363
	4,252		4,189
	3,677		3,191
	9,011		8,771
23,513	23,448	21,680	21,134
7,336	7,081	6,664	6,508
58,349	55,340	60,183	53,107
3,555	4,061	4,197	4,272
1,213	505	1,096	625
11,758	12,019	11,678	9,545

are given. [c]Includes data for spreader and calendering-type resins. [d]Includes data for acrylic, nylon, and other molding materials. [e]Includes data for epichlorohydrin, acrylic, silicone, and other protective-coating resins. [f]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.

HARSHAW PIGMENTS

INORGANIC PIGMENTS

Harshaw Pigments find widespread application in industry, especially where an inorganic type of pigment is desirable, such as in automobile and sign enamels and lacquers, permanent inks, resin and latex emulsion paints, plastics, artificial leather, fire-retardant coatings, rubber goods, wallpaper and artists colors. Wherever they are used, Harshaw colors show outstanding brilliance, strength and light fastness.

Yellows... Cadmium Lithopones and C. P. Cadmium Pigments—Primrose, Lemon and Golden
Sun Yellow N and C—extremely durable pastel yellow pigments (Nickel titanium dioxide complex.)

Oranges.. Cadmium Lithopones and C. P. Cadmium Pigments—Orange and Orange Red

Reds..... Cadmium Lithopones and C. P. Cadmium Pigments—Light Red, Medium Red, and Dark Red

Maroons.. Cadmium Lithopones and C. P. Cadmium Pigments—Maroon and Dark Maroon

Blues..... Cobalt Blue and Cerulean Blue

White.... Antimony Oxide

Other Colors and Pigments

Harshaw also offers a broad line of organic pigment colors, as well as a full line of Aurasperse organic and oxide dispersions. The dry colors are for general color uses, while Aurasperse dispersions find application in emulsion paint formulations.

A partial listing

ORGANIC PIGMENTS

Dry Colors

Hansa Yellows
Benzidene Yellows
Pigment Scarlet
Fire Red Toner
Maroon Toner
Permanent Orange
Madder Lakes
Permanent Green
Blue and Violet Toners
Permanent Purples

DISPERSED PIGMENTS

Aurasperse Colors

Hansa Yellows
Yellow Oxides
Green Gold
Chlorpara Red
Toluidine Red
Naphthol Reds
Alizarine Reds
Chlornaphthol Reds
Phthalocyanine Blue
Ultramarine Blue
Pigment Green B
Phthalocyanine Green
Chromium Green Oxide
Carbon Black
Red Oxides

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Harshaw Cadmium Lithopones
Harshaw Aurasperse Colors
Harshaw Pigment Scarlet 25 AD
Harshaw Benzidine Toner Yellow 2222

Phenolics

(*From pp. 85-91*)

resins. It hasn't worked out that way but producers still have faith in the originally estimated 50 to 75 million lb. a year consumption. There were times last year when the consumption was running at rate of 18 million lb. a year or more volume but total for the year was probably a million or so under that figure, compared to 11 or 12 million lb. in 1956.

There are now various types of resin used in addition to the original dry-mix; in fact there are three different prices with the standard grade at 25½ cents. Coated sand is likely to become the most widely used of all because it is easier to handle. Hot melt, liquid and solvent type resins are used but the latter needs a little different equipment even though less resin is required.

There has also been a noticeable increase in the amount of resin used for sand cores in foundry work since foundrymen have become resin conscious.

Resins in the miscellaneous group include those used for foam, rubber reinforcing, some wood-waste bonding, lamp basing cement used also in radio and television tubes, premix molding, and floor wax. Micro-balloon bubbles are still awaiting results of test applications for use to prevent evaporation in oil tanks.

Plywood

The situation in plywood is confusing and can be only skimmed over in this brief report. The monthly reports to the Tariff Commission indicate that after a banner year in 1956 there was a serious decline in 1957 which is to be expected because of a decline in construction and the beginning of a growing competition from particle board. Then, too, the total sum of the monthly figures is never as big as those shown in the Government's annual report since several companies report only on an annual basis. It is also possible that several companies do not report at all.

According to the Douglas Fir Plywood Association, the production of softwood plywood was 4,500,000,000 sq. ft. in 1955; 5,100,-

000,000 in 1956; and 5.4 billion in 1957, in terms of ⅜-in. material. About 33% was exterior grade. Phenolic adhesives go into all exterior grade and into 8% of the interior. Medium-density overlay paper for plywood, which also uses phenolic, grew from 6 million sq. ft. in 1954 to 21 million in 1956 and high-density overlay (laminates) from 10 million to 15 million. The price of plywood dropped from $90 per 1000 sq. ft. in 1955 to as low as $70 in 1957.

Obviously the plywood figures don't agree with the resin sales even though less resin is now being used in the adhesive compound. But that's an old story in this classification and only a thorough investigation will ever get it straightened out.

Laminates

Industrial laminates were down in 1957, but decorative laminates were slightly up. The total was down somewhere from 5 to 10 million lb. under 1956. It is probable that the Tariff Commission figure is 20 or 25% under actual production because of faulty reporting by some of the manufacturing companies. When more strict reporting was required during the war years the amount of resin used was 80 million lb. and there wasn't nearly as much decorative laminate being made. Laminators don't believe that present-day volume is as much under that figure as the statistics would indicate.

Sales of decorative laminates in 1957 are estimated at about $70.7 million and square footage at around 170 million as compared to $66 million and 157 million sq. ft. in 1956. Every 10 sq. ft. decorative laminate is estimated to contain 1⅛ lb. of resin on a dry basis, including the melamine.

Last year's increase in decoratives, despite the decline in housing, was largely due to more widespread use in expensive-type homes, hospitals, store fixtures, counters, and an increasing use of large panels: 5- by 12-ft. units are now sometimes used as wall coverings, for example.

It is expected that 1958 will also see an increasing amount of decoratives used in kitchens, for wall board, in post-formed bathroom equipment, in occasional furniture and in elevators.

Sales of industrial high-pressure laminates were estimated at $74 million in 1957 compared to $77 million in 1956. This includes all kinds of industrials including silicones, epoxies, polyesters, and others. It is believed that about 2½ lb. of solid resin goes into each $10 worth of industrial laminate.

Industrial laminates declined because military aircraft was off; radios and television were down; miniaturization of electronic parts requires little or no laminate; loss of a Western Electric terminal block which is now cast polyester; loss to molded pieces. Printed circuits have not yet reached the volume expected but they are growing and should increase considerably as automation becomes more widely used. Printed circuits for automobiles are already on the way—one model will use them for 1958.—End

Urea and melamine

(*From pp.* 91-92)

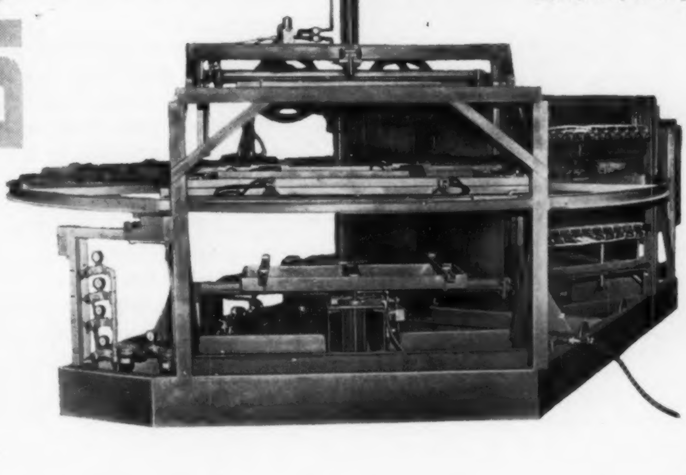
eral feeling that the over-all closure market will continue to increase, but there is some doubt whether urea and melamine will share to any great extent, because styrene serves the purpose well enough in quite a number of volume uses.

Wiring devices, especially such new items as interlocking multiple outlet strips made of urea, contribute to a sales figure which is largely tied in with the ups and downs of the building industry. Mineral-filled melamine for electrical uses, such as circuit breakers, mainly in aircraft insulation, guided missiles, ground power generating equipment, etc., showed a slight but steady increase in 1957.

Plunger or transfer molding uses could yield a better market for alpha-filled melamines in competition with urea, but not with phenolics, which have a distinct price advantage, although lacking somewhat in sales appeal because of color limitations. The economics of plunger or transfer molding indicate that phenolics, costing about 20¢/lb. with a molding cycle of about one minute, produce perhaps 5% rejects. Urea, having the same molding cycle, but as much as 20% rejects, costs around 33 or 34¢/lb. Melamine, which costs 45¢/lb., has a molding cycle of about 30 sec. and almost no rejects, making it more economical than urea, but still somewhat more expensive than phenolics.

Some growth in the buttons business may result from the issuance of a military specification limiting the choice of materials to melamine, because it can be autoclaved. Melamine has captured a large section of the electric shaver housing market from urea because of its superior resistance to heat and staining from perspiration, soaps, and lotions commonly used in the bathroom.

There is thought to be about 5 million lb. of miscellaneous materials other than that used for molding in "all other uses" shown in the table on p. 91. It is used for ion exchange, leather treatment, and various other uniden-



tifiable products of small-volume use.

Urea adhesives, always victims of vicious price cutting, have now reached a level which is very close to being uneconomical for the manufacturers. The price for 65% solids adhesive has been quoted as 8¢/lb., but in some areas of the Southeast it is said to sell even below this figure. The plywood industry is facing very strong and increasing competition from Japanese imports, but the growth of the chipboard or particle board industry not only offsets the losses for urea adhesives but actually shows a slight gain. Here again, chipboard manufacturers feel that the price of urea should come down even further, although there seems to be no attempt to manufacture adhesives for captive consumption—a logical step the chipboard industry would take, if it felt a price advantage could be obtained. It is still somewhat surprising that powdered adhesive is not used more extensively in the furniture industry, especially as the cost of the glue in a $500 piece of furniture amounts to only about 60 to 80 cents. The trend for urea adhesives is exactly that of the lumber industry—down for plywood but growing for other bonding uses, because of the expansion of the chipboard industry.

Both urea and melamine have a promising future in the paper-coating field, especially for imparting wet strength. Filter papers in the automotive field, air and liquid filters, and separators for dry cell batteries, offer good markets for urea and melamine, although phenolics might be a strong challenger in several applications. Filter papers are constantly growing and finding new uses in industrial applications, but it is difficult to ascertain, at this stage, what percentage of urea and melamine resins is actually used for paper treating. Melamine not only gives better wet strength and has a clear advantage where quality is a factor, but it is also faster curing than urea.

Paper technology has advanced significantly recently and it is now possible to impart higher wet strength more quickly and by using less resin, which may increase the use of urea and melamine. Although the addition of synthetic latex has great promise for water- and grease-proofing, melamine and, to a lesser extent, urea, will be incorporated in such processes.

The protective-coatings field continues to grow modestly. There are ups and downs, but a five year period shows a consistent increase, although alkyds continue to make inroads. The automotive industry requires a finish that retains its gloss longer, so that used or stored cars continue to look well. This can be provided by coatings, using an alkyd-melamine modifier, having a higher melamine content. It is expected that this will contribute to further expansion, although there is a possibility that methacrylate lacquers may some day offer very strong competition to melamine. General Motors, it is reported, will use some methacrylate lacquers in the immediate future, but, as yet, there are no indications that the automotive industry is rushing to follow suit.

The textile industry is in one of its periodic depressions and, to some extent, this affects the sales of urea and melamine for wrinkle-resistant finishes. In general, however, resin sales have grown steadily over the last five years. The price pressure put on materials suppliers manifests itself mainly in a switch from the better but more expensive modified melamine resins to the less expensive ethylene-urea-formaldehydes, or the least expensive urea resins.

The main growth in recent years has been said by some to be due to the ascendency of cotton over rayon, so that ethylene-urea-formaldehyde, used for treating cotton, has increased correspondingly. Melamine also has a good market in cotton finishing, but urea figures to a much lesser extent.

No new uses for urea and melamine have been developed which would affect the general volume, but treating ribbons for the florists' trade with urea to impart waterspotting resistance is one application which may lead to similar developments with potentially larger volumes.—END

Cellulosics

(*From pp. 92-94*)

fell a little behind 1956 in the first half of 1957 but picked up enough momentum in the last half to make a few million lb. gain for the year. Increased automotive business in September and October is thought to have been largely responsible for the better showing. The continuous increase in poundage every year since 1953 may be due to butyrate, since that material is now about 60% of this 95 million lb. market.

Stability of the cellulosic molding market is far less than that in the old established thermosets, where the major products are more firmly established. It is not uncommon in the cellulosics industry to lose most of an outlet and then gain it back in a short time. Such was the case in beads. Acetate once enjoyed a 5 to 6 million lb. annual use in this field. Then polyethylene beads took over, but acetate started to recover the market in 1957.

Military uses for cellulosics, including cellular Strux, and exports are still requiring a fair amount of material but there are few guesses available as to future possibilities in these areas.

Producers expect the increase of cellulosics to continue indefinitely even though Hercules has discontinued making the materials. Several comparatively small companies are now producing acetate molding material from flake and it may be that their combined activities plus that of the older companies will bridge the gap left by Hercules.

Prices of acetate have continued upward since late in 1956 when opaque colors were raised 3 cents. A 2¢ across-the-board raise was announced in the fall of 1957 which makes opaque colors now 41¢, translucents 48¢, and transparents 52 cents.

Sheets, rods, and tubes have exhibited unusual volume stability over the past three years. Some of the sheet is used for vacuum forming. The graphic arts industry uses large quantities and the growing number of motor scooters has added to the need for acetate windshields. Lamp shades have declined severely but there

are indications that this is another market that is coming back.

Sequins, cut from 3 to 5 mil acetate sheet, look especially promising for 1958 and '59. Fashion magazines have been showing high-style women's clothing heavily bedecked with these decorations. Apparently fashion plays a highly important part in the progress of cellulosics.

Eye glass frames have gone heavily toward acetate sheet in the past 4 years; today all frame fabricators are using acetate. Aluminum tried to get into the field but is used now only for trim. Acetate eye glass frames are made of laminates, which give a much more versatile variety of combinations to work with than aluminum and thus cater to that "fashion" angle.

Almost 40 million lb. of cellulosic film was sold in 1957, and by far the biggest portion was acetate. Largest growth since 1954 has been in the "over 3 mils" classification. The markets for "under 3 mils" have been remarkably stable with little change in volume and no new uses.

Probably five to six times more cast film is produced than is extruded. Surface problems with extruded film have never been completely overcome.

Chief outlets for less than 3 mil film are magnetic, electrical, and pressure sensitive tape; window boxes; window envelopes; and wrapping. Extruded film in this classification is being pushed particularly for wrapping shelf goods because it can be easily dusted off and the transparency helps to detect pilferage.

Film over 3 mils has grown more than that under 3 largely because of use in vacuum forming and automatic production of containers. It, too, is widely used for protective coverings, envelopes, cards, and similar uses.

The total of 140 million lb. of cellulose esters consumed in 1957 is an increase of 27% since 1954. The same rate of increase would make a total of over 157 million lb. in 1961. Furthermore it's a business that isn't overcrowded with the ambitious entrepreneurs who have made life miserable for the newer, large-volume plastics.—END

Acrylics

(*From pp. 94-95*)

tially polymerized methacrylate which has solvent resistance equal to that of cast methacrylate sheet. It does not show evidence of hydrolytic instability; it keeps the glass fibers wet; it preserves adhesion; and it is claimed to have as good as or better impact than resilient polyesters of the type that use more adipic than maleic acid. It is also reported to have beauty, weatherability, and impact superior to most present-day reinforced laminates at a cost of only a few cents more per pound for the resin. Cost is kept low, of course, because methacrylate monomer is only 29 cents a pound.

Methacrylate molding powder volume was thought to be considerably higher in 1957 than in 1956, especially since the industry was caught with a big inventory in the early part of 1956 and there was no similar experience in 1957. Automotive moldings continue to take over half of the methacrylate molding powder output each year with a gradual increase in the over-all average size of each molded piece.

Larger molded pieces in other applications are also the order of the day. Five years ago molders couldn't have taken such orders because there were no resins that would give the required flow. Today there is a molded control panel on an automatic washing machine that is 26 in. long and weighs two pounds. There is a new lighting diffuser that is 48 by 16 in. and has a weight of approximately 6 pounds.

Lighting fixture grids, always a tempting appetite builder for methacrylate molders but an economic problem to prospective users, have been extremely slow in developing. They have much longer life than other plastic materials used for the same purpose but long life has always been a hard property to sell compared to initial cost.

Other comparatively new methacrylate moldings that imply wider spread in application use are a new brilliantly colored housing for a ladies electric shaver and new molded signs for Shell attached directly to the pump where sharp detail must be obtained because the customer gets a close-up look. Weatherability and resistance to gas and oil of course add to the usefulness of this newer-type gas station sign.

The sheeting situation in methacrylate is about the same as in 1956 with a 10 or 15¢ increase expected in volume even though military use was down in 1957. The distribution system has been vastly improved and it is now generally possible for a user to obtain small quantities, even one sheet if desired, without much trouble. There are at least four major sheet casters now operating and all of them report good business. They all buy monomer instead of using reprocessed material, which has improved the quality of sheet now on the market. The former process of cracking scrap to recover monomer has largely disappeared because of the low cost of monomer. Extruded methacrylate sheet made little if any noticeable progress in 1957.

There are also some interesting happenings in **acrylic coatings,** of which there are several varieties. One uses standard polymers in a solvent for anti-tarnish lacquer on bronze hardware and automotive chrome. Then there is the new polymer mix for automotive lacquer. And best known is methacrylate and acrylate in an aqueous dispersion for latex paint. In 1956 it was thought that about 5 million lb. of resin were used for this purpose; industry spokesmen believe that in 1957 it jumped to perhaps 12 million.

Oil additives are still another use for methacrylate polymers. About 3% by weight is added to premium auto oil to maintain normal viscosity when the weather changes to extremes of heat or cold.

There has been no particular change in capacity for methacrylate monomer. The combined total of Rohm and Haas, Du Pont's new facilities, and Hercules is expected to reach 160 million lb. when announced facilities are completed by 1959. Consumption today is estimated at less than 75 million pounds.—END

Polystyrene

(*From pp. 95-97*)

molders thought it would go still lower. Consequently they operated from hand-to-mouth with no inventory build-up. That is one reason why the booming first-quarter sales were considered a harbinger of the greatest year ever for polystyrene. But apparently orders dropped off in the second quarter and molders, feeling that a price cut was coming in July, didn't buy an ounce more than they needed.

After six weeks of haggling—with each producer trying to gain a measure of competitive advantage and with most of the differences revolving around size of order and method of shipment—the situation finally cleared up in August with general-purpose, crystal polystyrene priced at 25¢/lb. in 20,000 lb. lots and over.

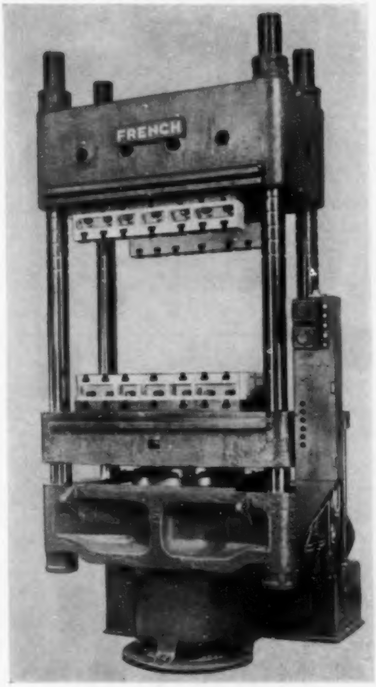
High-impact polystyrenes were not affected—are now 32¢/pound. Super-high and copolymer prices also remained unchanged.

Some observers believe that unmodified polystyrenes (25¢ polystyrenes) will start to decline after 1958 but leading producers will hold to no such philosophy. They agree that any producer or processor who fails to promote and develop new markets over the next few years will suffer, but are disdainful of any thought that their own companies may witness a severe decline in unmodified polystyrene soon.

An examination of how estimates on styrene type resins are separated into their various classifications may help explain why it is possible for total volume to grow even though unmodified resins may decline.

Estimates on sales of high-impact material in 1956 vary from 115 to 170 million pounds. After listening to the evidence a guestimate here is 150 to 155 million. The acrylonitrilestyrene types are guessed at from 10 to 13 million. Cycolac and Kralastic types were perhaps 18 to 20 million. Thus from a total of 402 million lb. in 1957 some 210 to 230 is left for unmodified and miscellaneous and the latter shouldn't exceed 15 million pounds.

Estimates on sales of high-im-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pact material in 1957 vary from 130 to 180 million pounds. A guestimate here is 175 million. The acrylicstyrene copolymers are estimated at 15 million and other copolymers at 25 million. Thus from 400 million lb., some 185 is left for unmodified and a small amount of miscellaneous.

The vast difference of opinion found among the estimators seems strange in this day and age when business firms generally know what their competitors are turning out. The differences may be due to deliberate efforts to confuse. But on one point there can hardly be confusion: Impact styrenes are increasing in volume and unmodified polystyrene volume has failed to show much increase in the past two years. This may be temporary.

A 25¢ plastic has a tremendous economic appeal for many uses and it could well show up in one or several applications that could involve millions of pounds of material. It is still too early to rule out unmodified polystyrene as one without growth prospects.

Unmodified or general-purpose polystyrene is no longer a true classification anyhow—it's merely a convenient handle for all types that sell at 25¢ a pound. There is no longer a single resin that can be used for everything. Each resin is now formulated with emphasis on one or two properties such as faster cure, better flow, better clarity, higher heat distortion point, better aging. Furthermore, machine techniques are constantly improving and a molder can now get better results from his resin at less cost to him. It is these steadily improving resins and techniques plus promotion and market development efforts which make some producers hopeful that so-called unmodified polystyrenes will grow in good volume. They are not unmindful of growing competition from other plastics but believe that low-cost polystyrene will continue to grow even though the impact styrenes may take a greater share of the market. In other words, there will be a parallel growth of all styrene-type resins to put the total over a half billion-lb. by around 1960.

Among the possibilities for growth in specialty resins that may still be classified as "straight" polystyrenes are film and phonograph records. The Monsanto-Plax oriented film is beginning to make headway as a vacuum forming material and has a low-cost advantage over its principal competitors. The Dow film is still listed as developmental but is now moving into the window-envelope field where it has overcome adhesive and static problems. When heat-sealing becomes practical, this film may move into major markets. Polystyrene phonograph records have now taken over a large portion of the 45-r.p.m. market but so far have not moved into the larger 33-r.p.m. field. The future for polystyrene in the record business is still a matter of controversy between the record producers. Amount of resin used is estimated at 8 million lb. in 1956, 10 million in '57, and will perhaps be 11 million in '58.

In modified styrenes it is expected that a great part of future growth will be in extruded sheet. The 1956 volume is estimated at from 45 to 55 million lb.; the 1957 volume at from 55 to 60 million. About 65 million is forecast for 1958. It may grow at a much faster rate when on-stream fabrication, a term for automatic production from extruder to finished product, becomes prevalent. This type of operation is most likely to take place in captive plants where the user of the finished product becomes its producer.

All medium- and high-impact styrenes are expected to grow at a rate of about 10% a year for some time but present-day impacts won't be recognizable five years from now. Much of the past improvement has been in ease of molding but strength has been improved by 60% without loss of other properties such as aging. Loss of one property to gain improvement in another has been a troublesome factor in the past but the business of improving such things as heat resistance or aging without sacrificing ease of molding is progressing. Clear impact material, in the laboratories for some time, still has its practicality limited by high cost.

Growth of improved impacts

will depend upon industrial uses such as refrigeration but unless good engineering is involved there will be a collapse. It's no use to build a good egg shelf, for example, if the processor listens to the plea for a lower price and cuts the quality of his molding.

The super-high impacts include less than 10 million lb. of the total impact volume. High cost plus the fact that ordinary high-impact will generally do the required job have held back their growth. More strength and higher temperature resistance must be built in to improve acceptance of the supers. Such improvements might move them into more direct competitition with the copolymers.

Copolymers, as mentioned previously, have grown from an estimated 32 million lb. in 1956 to 40 million in 1957. Cycolac and Kralastic are growing, but together they probably don't account for more than 25 million pounds. Attention in 1957 was particularly centered on the styrene-acrylonitrile copolymers, now in production by three producers. Transparency and chemical resistance make them particularly adaptable for tumblers, battery cases, hair curlers, etc. If this material's price ever gets down into the lower half of the 30¢ price range, volume could grow immeasurably. Styrene monomer and acrylonitrile prices have been coming down steadily over the years but there is yet no indication that the copolymer will drop below the high 30's.

The pattern for styrene-type resin end uses has been changing considerably over the last few years. Uses in refrigeration and air conditioning equipment dropped from an estimated 75 million lb. in 1956 to 70 million in 1957 with no prospect of growth in 1958. Material used is 90% impact. Refrigerator boxes were down 14% but use of polystyrene increased per box. Some day the industry expects to get the whole inner lining which would boost average use per box from the present 20 lb. to something in the neighborhood of 30 pounds. There is some growth in grilles and parts for air conditioners but polystyrene can't be used for cabinets because of its poor resistance to outdoor exposure.

Toys are estimated to have used 42 million lb. in 1956 and 1957 and will be about the same in 1958. Use of snap-on assembly instead of cementing and the invasion of the hobby field by impact polystyrene has stabilized the market.

Wall tile suffered a 10 or 15% decline in 1957, poundage volume being only slightly above 40 million pounds. Housing and remodeling declines were partly responsible but ceramic manufacturers came out with a low cost 65¢/sq. ft. product that can be self-applied. It cut into plastic business where tile producers are battling each other over prices and have nothing left to use for promotion. Prospect looks no better for 1958.

Housewares seem to have lost whatever they are going to lose to other materials. Use of polystyrene has stabilized at around 30 million lb. for 1956, 1957, and probably 1958.

Packaging use is most difficult to estimate for both today and the future. Perhaps 50 million lb. in 1956, 56 million in 1957, and maybe 63 million in 1958. It is a surprisingly difficult technical field. Out of hundreds of applications studied, probably only 8 or 10 ever work out. Business may end up entirely in the hands of container people only or imaginative molders who have the capital and initiative to establish and grow into a large container company rather than remain a plastics molder. Anyone who wants to make a success in the container business must be a part of that business.

Industrial and miscellaneous includes such items as lighting fixtures that may grow from 7½ million lb. in 1957 to perhaps 20 million in 1959 or '60. Furniture drawers used about ½ million lb. in 1957, may use 2 million in 1958 or '59. New ideas such as the flower pot vacuum formed from black sheet help account for many millions of pounds. Then there are the older applications such as radios and clocks, combs, brushes, novelties, and premiums that go on from year to year without much change and have

been consuming around 80 to 90 million lb. per year for several years.

Polystyrene foam is recorded partly in molding materials and partly in miscellaneous in the table on p. 96. It is believed that at least 10 million lb. of resin were used for foam in 1957. Some idea of volume may be attained from the fact that foam weighs 1.7 lb./cu. ft. and that 5½ board feet can be produced from a pound of resin. Fire-resistant foam weighs 2.3 lb./cu. foot.

Chief use for polystyrene foam is insulation for dairies, food processing, breweries, meat packers, pipe, vehicles, and perimeter insulation for housing. Cement panels with polystyrene foam cores speed up construction at a terrific rate. One big new building went up in 8 days when using these panels. A new idea is Dow's Scorboard, a black, smooth-surfaced board of foamed polystyrene which is 8 ft. long and 2 ft. wide but scored at 3, 12, and 20 in. marks across its width so that the user can snap off whatever width he desires for a particular application.

The biggest volume use in "other resins" in the table on p. 96 are the high-styrene butadiene resins used for rubber reinforcement, mostly in shoe soles. The total for this material is estimated at less than 30 million lb. a year. The price is now 36¢, down 3¢ from a year ago and 6¢ from four years ago.

The figures in "Protective coatings" and "Resins for other uses" have been sorely confused over the years because of conflicting methods of reporting. For example, coating resins (styrene-butadiene) have frequently been reported in both classifications. This no doubt explains a higher figure in the "other resins" than anyone could understand and why the coatings figure was apparently low. This year's Tariff Commission report is abnormally low in coatings because of this situation. Producers insist that sales of styrene-butadiene coating resins in 1957 was well ahead of 1956 despite the claims of competitors who produce acrylic and vinyl acetate materials for coating resins.—END

Vinyl chloride

(From pp. 97-101)

price of general-purpose resin may go down rather than up unless an inflation spiral becomes uncontrollable. There is much talk about large quantities of resin being sold for less than 27¢, the standard list price, but investigation indicates that nearly all those rumors relate to off-grade or Class B resin which has always sold for a few cents less per pound and is perfectly adequate for many of the applications in which it is used.

It is now well known that there is small profit in a 27¢ resin, especially for producers of less than 50 million lb. capacity. Consequently, the older producers are likely to concentrate on the specialty resins such as dispersion and rigid grades which sell in the over-30¢ range. Those producers who do not have facilities and laboratories to keep up with this trend toward higher priced specialty resins will thus be handicapped in the future unless they can establish a line that gives more variety to their inventory.

Molding and extrusion have been the highest volume uses of any classification in vinyls, including film and sheet combined, for the last three years. Wire coating is the leading poundage consumer, as shown by the table on p. 100. Today there are at least 200 wire coating companies in the field and vinyl continues to take an ever-increasing portion of the market. Most of the resin used for wire coating is dry-blend type. From 60 to 70% is Banbury or mill mixed but a dry-blend type of resin is used because it absorbs the plasticizer more quickly. Most of the older producers now market a dry-blend resin although one of the largest did not enter the field until 1957. That company then announced a technique which, together with its new resin, made possible 10 to 15% faster processing than with conventional dry-blend resins. The company claimed the resin and process to be the most important developments in the vinyl extrusion field in 15 years and suitable for practically any product now produced by vinyl extrusion.

Radical improvements in vinyl for wire coating are expected to be anounced in the near future. One will be a resin with a 10° or more improved heat resistance which should broaden the field for wire coating by millions of pounds. Another is an entirely different type of formulation than that now used, which will purportedly upgrade the resin's properties to a considerable extent and again add to its usefulness.

The progress of vinyl-coated wire in the past year has been doubly gratifying because chaos in the copper industry hampered wire production and because there was such a small increase in automotive production and a decline in housing. The only answer to the increased use of vinyl in the field is that it has cut more deeply into the volume of other wire-coating materials.

Vinyl in phonograph records continues to increase even though radical changes have been going on in the industry for several years. Vinyl is the principal resin used for long-playing 33's but has lost part of the 45-r.p.m. market to polystyrene. There is some dispute among the various record producers as to which will be the resin of the future for records, especially since polystyrene has not been applicable to the 33's because of their large size, but vinyl is expected to remain well-entrenched for an indefinite period. The older records (78's) are still manufactured in fairly large quantity and use a variety of materials including vinyl mixed with other materials.

The continuing increase in use of vinyl for molding is due largely to an ever-growing plastisol slush-molding industry. Increase in profile extrusion may be credited to increased use of welting in automobiles but there are so many applications in this classification that it is difficult to pinpoint any particular area of growth.

Garden hose, also a profile extrusion, has dropped in consumption of virgin resin for several years; the market has been taken over largely by reprocessed material. The figure in the table on p. 100 may be low since some of the reprocessed resin is "sweetened up" with a bit of virgin resin and a good portion of Grade B resin is used by the hosemakers. There is no doubt that the industry has suffered from the down-grading of garden hose made from low-cost compounds but the hose producers got into a cat-and-dog fight over price and there is little sign of improvement on the horizon. Some transparent hose, which requires virgin material, is still on the market and some plastisol is used as a coating on a scrap base. These two account for most of the Grade A resin used for garden hose. Among the brighter aspects in this field is a new nylon-reinforced vinyl hose which should move into large-scale markets.

The rigids or unplasticized vinyls are making steady increases but will probably move much faster starting a year or two from now. Potential customers in this field are still loath to experiment on a big scale until such properties as aging and strength have gone through years of testing. As discussed earlier in this article, the rigids must have more time to develop before they can come into big-volume use.

A feature of growth in 1957 was the increase in production of extruded shapes other than pipe. Pipe is about an 8 million-lb. market compared to 2 million lb. for shapes such as ducts and housing, but the latter comprise an area where there was almost nothing a year or so ago. One air-conditioning equipment manufacturer is producing an extruded saw-tooth-shaped baffle which serves as a moisture eliminator for industrial units. Extruded shapes are also used as insulators for metal contacts on overhead power lifts; links in continuous belts; runners for bowling ball return tracks; tracks, frames, and other window components; scuff-resistant moldings; wiring ducts; and all sorts of channels and insulation tubings.

Vinyl pipe is now used mostly in process industries such as paper and food but oil field applications are becoming established. The fittings problem has

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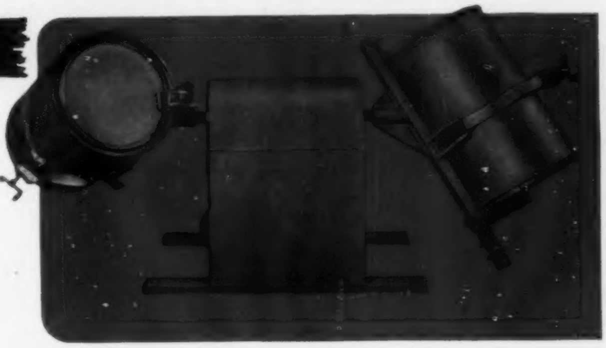

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been overcome since two large companies have entered the field. Threaded fittings have been in use for three years, but solvent welding and cementing of joints is growing in popularity because it is the easier method of joining.

There are now from 10 to 15 vinyl pipe extruders in business with probably enough capacity to take care of the market for years to come, but the potential market hasn't even been scraped as yet. Scores of companies who could use vinyl pipe don't even know about it. There is an estimated annual market for at least 50 million lb. of rigid pipe and shapes within the next five years and it could be at least 50 to 60% vinyl. Processing is now routine after an extruder has once mastered the technique, but the big problem is marketing and distribution. Price is now 42½¢ for vinyl pipe compound compared with 70¢ in 1952.

Plastisols are partially included in the molding figures given in the table on p. 98. Total amount of resin used for dispersion resins (greatest portion of which is plastisols) is thought to be over 80 million pounds. But that figure is a pure guess. The largest producer of such material has not released production figures. It is believed that the largest amount of dispersion resin is used for spread-coating on fabric but the molding figure is growing rapidly. Soft, hollow toys—particularly dolls—are the biggest item. Dolls alone may take more than 10 million lb. a year. In addition to giving life-like appearance and feel, plastisols are now practically indispensable to doll making since the saran hair on their cute little heads can't be satisfactorily fastened to other materials.

Another aid to plastisol growth has been the widespread acceptance of rotational molding which is easier, faster, and produces less waste than conventional slush molding. The method was explained in detail, "Plastisol viscosity-temperature characteristics," by W. D. Todd, D. Esarove, and W. M. Smith, Modern Plastics 34, 159 (Sept. 1956).

Other big uses for plastisols are in coating woven glass yarn for screens and in dip coating.

But the most interesting development in plastisols in 1957 has been in the rigids, as forecast in these pages in January 1957. Such formulations can be compounded to produce various degrees of surface hardness and give a tremendously wider scope to plastisols. One of the first applications was in an air-conditioning duct in an automobile where it superseded a polyester-sisal job, but in turn lost out to a lower-cost treated paper duct. The largest rigid plastisol application is a hobby horse and there are scores of other new applications in the offing.

Just getting started is spread-coating of vinyl plastisols on metal. Good adhesion was a stickler for a while but has been provided for by a special prime coat. It may be a year or two before this application grows big but it looks like big volume eventually, with vinyl-coated metal in color made useful for a num-

ber of structural and housing applications.

Foam made from plastisols is still in its infancy but looks more promising than it did two or three years ago. There are now three well known ways of producing foam from a plastisol. One is the Elastomer process which is mechanically blown. Also mechanically blown is the Dennis process which employs a pressure under 100 p.s.i. The third method is chemically blown and employs a blowing agent. Advocates of each method claim superiority but the chances are that all will be used if and when vinyl foam reaches big volume. Resin used for foam was probably less than 3 million lb. in 1956—not more than 5 million in 1957. However, both the urethane and vinyl foam pyrotechnics have been far too brilliant for their actual accomplishments and it now seems the better part of valor to wait and see before making predictions about the future.

It does seem, however, that vinyl foam has several advantages. It can be molded and heat sealed; apparently it ages better than either rubber or urethane; and it has better moisture resistance than urethane.

But vinyl foam has one drawback. It costs more because it has to be used in a heavier weight per cubic foot than urethane. A weight of 6 or 7 lb. cu. ft. against 2 for urethane was an early complaint, but usable vinyl foam is now down to 4 or 5 lb. in slab form, or 6 in molded form. Chemically blown closed-cell foam can be made at 2 lb. but even that is still 1 lb. higher than the rigid polystyrene foam with which it might compete.

Some of the applications for which vinyl foam is now being used or tested include: molded hand rests in automobiles; quilted fabrics with a decorative vinyl film covering heat-sealed to the foam; transportation seats; school seats; and a 1-lb. grommet in the Edsel automobile that fits around the steering column where it joins the dashboard.

Foam producers are hopeful that there will be much more progress to report on vinyl foam by this time next year. Among the expectations is an extruded vinyl foam made from standard resins which can be used around automobile doors to replace rubber, as insulation on storm doors, and as bumper strips on garage doors. It is made by a continuous process and is said to be less costly than rubber foam.

Floor covering continues as one of the fastest growing segments of the vinyl chloride business. The 19 or 20 million-lb. growth in 1957 was almost as high as the "miraculous" 22 million-lb. jump in 1955 and far ahead of the 1956 increase. Among the factors accounting for this are: a decline in the price of vinyl floor covering; further development of good-quality thinner grade tile; more widespread marketing and distribution; and increased general acceptance by the public. An 80-gage (about 1/10 in. thick) vinyl asbestos tile made great progress in 1957 as a supplement to the heavier 125-gage (1/8 in. thick) material. There was also a noticeable surge in the vinyl-treated paper-felt laminate which is made by only one company, but others are now interested.

There were some 1,300,000,000 sq. ft. of vinyl-asbestos and asphalt tile produced in 1957, of which more than 30% was vinyl-asbestos. Slightly more than 50% of all vinyl floor coverings produced is estimated to be vinyl-asbestos and to consume more than 60% of all the vinyl used in floor coverings. The resin is a 32¢ specialty material of the type used for phonograph records and can coatings.

The prospects are that resin used in floor coverings will soon be more than 100 million lb. but how much greater is still a matter of speculation.

Vinyl resin used in fabric treatment was about the same in 1957 as in 1956. The treated textiles went primarily into upholstery, a great portion of which was automotive, which did not grow to any extent in 1957. Then too there is a growing quantity of film or sheet laminated to fabric now moving into this field and cutting into the calender- and spread-coated output.

Calender-coating probably accounts for over 30 million lb. of

the resin used for fabric treatment. One reason why resin consumption is higher for calender- than spread-coating is the fact that the coating is much heavier, running from 12 to 20 mils. A spread-coater would have to make too many passes to achieve such a thick coating. Practically all calender operators are now or soon will be in the post-calendering business which in most cases is a continuous operation starting at a compounding station and ending with a finished sheet-to-fabric lamination. There are so many advantages to this system that it may outmode conventional calender coating completely except for exceptionally long runs.

At least half of all calender coated material today is for transportation purposes. Most of the balance is for furniture, luggage, wall covering, the shoe trade, and hand bags. One producer's estimate of the vinyl-coated upholstery market, in 1000 lb., is:

1954	Automotive	8,300
	Other	2,000
1955	Automotive	15,000
	Other	3,800
1956	Automotive	9,800
	Other	2,500
1957	Automotive	10,000
	Other	2,500
Basis:	½ lb. resin/yd. upholstery	
	¼ lb. resin/door panel.	

Spread-coating is now done almost entirely with plastisol resins. Volume goes up somewhat each year. The coated materials are used on lightweight jobs such as wall coverings, table cloths, gloves, certain types of upholstery, tarpaulins, shoes, and such. Intense competition from film-to-fabric laminates is developing but there is a wide difference of opinion concerning the relative merits of the two methods and it will take time to determine how the various applications will be divided.

The amount of resin used for film and sheeting as reported in the monthly Tariff Commission reports has caused more conversation than almost anything else in the vinyl chloride industry. The total resin used in 1957 for film under 10 mils will be over 90 million lb., if the Tariff Commission figures continue in the last quarter at anywhere near the rate of the other quarters. That would

make 1957 by far the greatest year in vinyl history. The first quarter was a booming 25 million lb. and the second and third quarters were over 20 million. The figure includes 6 or 7 million lb. of cast and extruded film, but even so it is a high figure and does not include foreign resin or resin from non-reporting firms.

Film producers can't explain the exceptionally high first quarter and most of them insist that business for the industry just hasn't been that good. At the same time, many of them state that their own volume has been exceptional. When these conflicting statements are put together an observer is bound to assume that the over-all film business has been better than believed but individual companies have lost track of their competitors' activities!

Perhaps one reason for this interesting situation is that volume is tremendous but profits are so low that everyone is singing the blues. The price structure and the rumors about price cutting are certainly not conducive to a good profit picture. But the "blues criers" are so vociferous that it is hard to disbelieve their claims that the film business is not as good as it looks in the figures.

Another possibility is that greater quantities of film are going into laminates than is believed. Processors who had been using sheet for laminating to fabric switched a great part of their output to film early in 1957 when they found it answered the purpose adequately. Laminated wall coverings and nylon-to-vinyl film tarpaulins are further examples of large volume use in 1957. But it seems unlikely that the volume of laminates could have been big enough to make such a difference of opinion.

Still another possibility is that there may be confusion in reporting to the Commission and that resin used for sheet was inadvertently reported as film grade.

In any case, the situation is most difficult to evaluate and indicates once more that probably the only satisfactory solution is to combine film and sheeting resin into one classification.

Resin suppliers estimate that the total for film and sheeting

grade vinyl is somewhere between 155 and 165 million lb., including unreported resin from the new companies and excluding foreign imports. The Tariff Commission report for both film and sheeting will probably be about 145 million lb., depending on what happened in December, but will *not* include either foreign resin or resin consumed by six of the new companies.

Modern Plastics' guess is that the amount of domestically produced resin used for film and sheet in the U. S. in 1957 was in the neighborhood of between 165 and 170 million lb., up about 35 million lb. from 1956. In a situation such as this a 10% margin of error should be permitted.

A point to remember in estimating the amount of resin for sheeting is that 15 or 16 million lb. was used for rigid vinyl, an increase of 2 or 3 million lb. over 1956. That is almost double the amount produced four or five years ago. Among the new calendered rigid vinyl sheet applications is a milk bottle cap that can be turned out on a new vacuum-pressure forming machine at a rate of 700 or 800 a minute. Forty or 50 million have already been produced. Rigid vinyl lighting pans have also been increased in size from 2 by 2 ft. to 4 by 4 ft. and a 5 by 5 ft. size is in prospect. Large pieces of television scenery up to 6 by 10 ft. are being made and panels for signboards are another possibility. Vinyl point-of-purchase signs have also more than held their own against impact styrene and such applications as binders for portfolios, charge plates, printing plates, playing cards, and ducts are going strong.

A breakdown of vinyl film use is given in the table on page 99. There are no accurate figures available and this tabulation is a composite of estimates by leading film producers. It gives a reasonably accurate picture of trends. The total seems low, especially since there is so much confusion about the amount of resin used in film but several film producers insist that it is a few million pounds high. However, whether high or low, it does not affect the purpose of the tabulations.—END

Polyethylene

(*From pp. 101-105*)

about ready to announce availability of a molding resin. Koppers is expected to start production in January. The others

1960 Low-pressure capacity

	Million pounds
Phillips	75
Union Carbide	55
Celanese	50
Grace	50
Dow	30
Du Pont	30
Hercules	30
Koppers	30
Allied	30
Goodrich	50
Monsanto	?
Spencer	?
Texas Eastman	?
Total	430

in the list above have not yet announced commercial production—Goodrich has done nothing but announce selection of a site. And then there are Monsanto, Spencer, and Texas Eastman which have announced only construction of pilot plants.

Progress in low-pressure-processed polyethylene has been slower than originally anticipated. First, the process of producing an entirely new resin by a new technique has not been easy. Phillips, for example, first gave the impression that a one-purpose resin would be most practical but is now advertising four variations. Problems of creep, stress cracking, odor, catalyst removal, and many others have had to be overcome. The industry has had to learn all over again that a new plastic doesn't blossom over night.

Secondly, the new polyethylene was so loudly ballyhooed a few years ago that molders probably felt they would have a material which could be dumped into any mold and produced forthwith. Such was not the case. Like any new plastic, low-pressure polyethylene must generally be handled by different techniques and new molds are usually required. The material does have improved properties over conventional polyethylene for many uses. Finished

products can be boiled; they have a smooth, glossy finish; they are more rigid or stiff; and they are more impervious to oils and gases. Laboratory equipment, mixing bowls, containers for kitchen grease from the frying pan, toys, and a few other items of highly satisfactory appearance are on the market. Monofilaments for seat covers and marine rope look good for the future. Bottles are practically an assured big future market.

Pipe to compete with rigid vinyl and metal is a sought-for market still in the uncertain stage, although Allied claims to have made marked progress with its higher-than-usual-molecular-weight material but competitors say its high molecular weight makes it difficult to process.

Film still has problems of clarity, brittleness under load, fisheyes, and others not yet overcome. Some experts claim that if a good film is to be obtained from low-pressure polyethylene, a new film-making method will have to be devised. There are others, however, who are anticipating a fair market from low-pressure film just as it is. Crispness and stiffness give it a marketable appeal, they assert.

Wire-coating uses for the new material do not look as promising as they did two years ago. Nearly everyone has lowered his estimate to include only a very small portion of the market, although Bakelite officials, who should know about polyethylene wire-coating, are quite optimistic about prospects of low-pressure material in this field.

Perhaps the greatest hold-back to more widespread use of low-pressure polyethylene is price. The chances are that molders and other processors will learn how to use it quickly enough when the price comes down, just as they learned how to use polystyrene and nylon after loud-voiced complaints about troubles. Molded samples in housewares, for example, have such a gorgeous appearance that it is impossible to believe they won't take a houseware show by storm just as soon as the price is competitive with lower cost thermoplastics.

Molders, of course, will have their eye on the new polypropylenes, especially since it is claimed that molds built for other plastics can be used for polypropylene, but supply will be limited for a year or two and the price is high.

As is obvious from the above statements, it isn't possible to chart a clear course for the near future of low-pressure polyethylene. If sales go over 50 million lb. in 1958 many estimators will be surprised. Nevertheless, it's here to stay; how big and how soon are beyond the scope of any man's crystal ball. The table below is a compilation of estimates by various raw material producers on how large the markets will be in 1960 for both polyethylenes. After all, 1960 is only three years away, which isn't much time for spectacular growth. But after 1960 there is a possibility that volume may double in five years' time.

This table will no doubt promote considerable controversy. Low-pressure producers are hopeful of gaining a much larger share of the market and high-pressure producers think the low-pressure estimate is high. The high-pressure producers also disagree on the amount of high-pressure material allotted to the various products in the table and think the total is low. Neverthe-

Polyethylene sales estimate for 1960*

End use	*High-pressure* *million lb.*	*Low-pressure* *million lb.*
Packaging film	230	20
Construction and agricultural film	35	10
Other film	20	5
Sheeting	5	10
Coating	65	10
Molding	125	80
Bottles, jars, tubes	35	15
Wire insulation	105	15
Pipe	75	15
Monofilament	0	10
Other extrusions	20	10
Export	60	15
All other	25	10
TOTAL	800	230

* Figures in this table are a combination of estimates submitted by several material producers.

less, these are tremendous increases over the 1957 figures and are so high that one could be forgiven for being a little bit "queasy" if he wonders just how such an accomplishment can be achieved.

The totals in the table at the beginning of this chapter on polyethylene (p. 102) were also put together after much difference of opinion among the various producers. There is a wide area for error in this compilation but the figures are a compromise developed from numerous opinions and interviews.

Reasons for such variation of opinion include: producers cannot always tell what their material is used for because millions of pounds are handled through some 30 or more resale outlets such as jobbers, compounders, and reprocessors and the end use for that material is difficult to ascertain; no one is certain how much virgin material is used to "sweeten up" the large quantities of scrap used in the industry; the difference between scrap and off-grade material sold at less than standard price confuses the issue even though off-grade is supposed to be reported to the Government as virgin resin and is so considered in this MODERN PLASTICS compilation.

Estimates for sale of resin used in film production varied from 185 to 230 million lb. in 1957. It seems that no matter what the total poundage of polyethylene may be, film resin always takes about one-third. Even the five-year estimates are based on that assumption, except by one producer who is so bold as to predict that 40% of high-pressure resin will be used in film in 1962. Film has grown in quantities of from 40 to 50 million pounds a year since 1955. At that rate it will be in the neighborhood of 350 by 1962. Film is by far the largest volume use of polyethylene now and is expected to continue as such. There are reasons to believe that estimators are extremely conservative in their guesses on the future for film. They may even have been conservative in the past when estimating the output of their various competitors. Then again it may be that some astute observers noticed the decline in film sales in mid-1957 and began to hedge on their more optimistic prophesies.

On the other hand, there are several reasons for a belief that film will continue to increase at a much greater poundage volume per year. Chief among these is that polyethylene in large-quantity orders at around 48¢/lb. and in small quantities at 52 or 53¢ is less costly than cellophane. When wrapping machines are more fully developed to use polyethylene, the amount used could double that presently going into packaging. But that is not likely to develop on a large scale before 1960; after that, it could zoom up.

A better profit situation in the converting field could also help since most converters are reportedly working on a 1 or 2% margin in an industry that is increasing at a 20 to 25% rate. That is an incongruous situation. If converters will improve their capital position and spend one or two cents a pound in promotion instead of instituting a five-cent price drop they would improve both their profit and volume.

Then there are packaging side issues such as the approaching 5-million-lb.-a-month garment bag and laundry business. These 16-mil bags now cost under 3¢ each, which is no more than paper.

Uses for film other than packaging are also developing. Perhaps 12 or 13 million lb. were used for construction in 1957. That figure can grow to 20 and perhaps more in 1958 or '59 if distribution and education in use of film are improved. Agricultural uses such as for mulch and pond linings were probably less than one million lb. in 1957 but represent a potential multi-million pound use if farmers can be taught to use it and can buy it at local distribution centers.

Miscellaneous uses such as the 5 or 6 million lb. camel-back application are all around the place but total volume is not large. Sheeting for liners and vacuum forming is another promising item but not in the high volume accredited to film.

The molding figure has grown

(*To page* 223)

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OFFSET BAR AND TUBE PRINTER. Leaflet gives description of versatile machine which can be mounted on the production line for printing on the lineal surface of round, poly-sided and extruded shapes of molds. Jas. H. Matthews & Co. (A-811)

PROCESSING MACHINERY. Literature offers a variety of standard mills from 6" x 12" to 26" x 84", and suited to plastics manufacture requiring heavy-duty equipment. Illustration shows all points of construction, with a short explanation of all parts functions. Erie Engine & Mfg. Co. (A-812)

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PLASTICS STAMPING PRESSES. Series of data sheets describes line of hot stamping presses, including both manual and power-driven types for decorating, printing, embossing, light forming and punching of small plastics parts and products. Specifications of each press included. The Acromark Company. (A-836)

CAST ACRYLIC SHEETS. 4-page file leaflet describes the properties of a new precision cast acrylic sheet possessing close thickness tolerances and high optical clarity and available in sheet form .020" to 0.5" thick and in clear or translucent form. Cast Optics Corporation. (A-837)

VINYL EXTRUSION AND INJECTION MOLDING COMPOUNDS. Data sheets give prices, properties and color information for a line of vinyl molding compounds, with suggested uses that include lead-free welting, channel and gaskets, and opaque tubing. The Blane Corporation. (A-838)

PERFORATING, SLITTING AND BLANKING. Booklet shows full-size reproductions of fifty-four perforating die patterns designed to service such industries as plastics, fabrics, leather, paper, rubber and allied fields. Other data includes a complete die list and suggested applications. Perforating Industries, Inc. (A-839)

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PLASTICS PROPERTIES CHART. Comparative properties of a new polycarbonate resin and other thermoplastic molding materials are outlined. The new polycarbonate plastic shows outstanding impact strength and a heat-distortion point of 280-290° F. at 264 psi. Other test data includes electrical and physical properties, as well as molding characteristics. General Electric Company. (A-841)

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largely on the impetus from housewares — especially large pieces such as buckets and clothes baskets. The figure in the table on p. 102 is lower than that of most estimators but great quantities of scrap are used in molding—especially for toys— and that factor reduces the amount of virgin material by a considerable volume. Molding is also a good market for a considerable amount of off-grade material but that is counted as virgin material.

Wire and cable insulation use is expected to double in 10 years' time. Intercontinental under-ocean cables have proved so successful that several more are contemplated. Each one requires from one to three million lb. of polyethylene. Communications cables are constantly using more polyethylene for sheathing. A 120 million-lb. volume for this use in 1960 may be high but it should be around that figure soon thereafter.

Estimates on volume use in **pipe** vary from 35 to 65 or 70 million lb. in 1957 but the variations are due largely to a difference of opinion on whether the material used is scrap, off-grade, or virgin. One producer claims that pipe producers don't care for film scrap because its melt index is too high and that the estimated scrap usage in pipe is therefore too high. The figure in the table is intended to include off-grade, but not scrap.

The amount used for **coatings** on paper, cellophane, and foil is another point in dispute, with estimates ranging from 25 to 40 million lb. in 1957. Many paper coaters operated at only 50% capacity in 1957 and there are still many technical and marketing problems involved. Coating is one of those fields that may not grow as large as expected but there is always a chance that it may suddenly "bust-out" to unpredicted heights.

Bottles, jars, and tubes includes metal-end cans, carboys, and barrels. Growth has been normal up to now but one good source foresees a tremendous increase by 1960 or '62 based on a belief that it will grow much faster in the next few years than previously and that bottles from low-pres-

sure polyethylene will add considerable poundage to the total.

The reader will note that only the designations "high-pressure" and "low-pressure" have been used to describe the different types of polyethylene in this article. The reason is because every reader who is interested has a definite knowledge of what those terms mean. The industry is struggling to find a standard terminology with such designations as density, linear, high modulus, etc., but none of them have met with universal acceptance partly because the terms overlap.

The so-called medium-density material, for example, which ranges from .926 to .945, will probably be made eventually by both the high- and low-pressure methods. So far it has been made primarily by high-pressure. Probably not more than 10 million lb. were sold in 1957 but that is only a beginning. It has certain film characteristics such as clarity and improved moisture vapor transmission but the higher crystallinity of the resin results in a film that is less strong under load. Higher temperature resistance than conventional low-density film and extra stiffness make it fit in between the extremes of low- and high-density polyethylenes. Cost is from 4 to 9¢ above standard polyethylene and that of course has affected its progress. It is significant that Du Pont, Spencer, U.S.I., and Bakelite, all of which announced substantial expansion plans for high-pressure polyethylene in the past one and a half years, have emphasized their intent to use a good part of their new facilities for medium-density polyethylene.

The future for all polyethylene is cloudy but it's a rather pleasant cloudiness that just keeps people from seeing how big it will be. An interesting comment from a contributor to this article was that there are at least 150 extruders on order today for processing polyethylene and that one operator was planning to install one a month during 1958. With that kind of enthusiasm for a product is it any wonder that a highly influential source in the industry says the volume will be more than 2½ billion pounds in 1967?—END

Nylon

(*From p.* 105)

their material is particularly easy to process and that large pieces can be produced without voids. The cooling fan blade on Citroen automobiles is cited as an example. The material is also claimed to be exceptionally adaptable to extrusion and it is expected that nylon-6 film produced from their resin will eventually find a market in the United States. An interesting variation along this line is a nylon film raincoat made in Germany of a nylon-6 and 6/6 mixture which sells at a relatively low price.

Another angle to the supply situation is the new Nylatron GS nylon which combines nylon with molybdenum disulphide and is formulated by National Polymer Products, Inc. Low coefficient of linear expansion and minimum distortion after molding make it particularly useful for close-tolerance molding.

Principal applications for nylon in this country now are appliance parts (gears and bushings); wire and cable coverings; consumer products such as combs, brush backs, fishing reels, and tumblers; hardware, locks, and drapery slides; automatic washer parts; industrial machinery parts; and automotive components such as small gears and locks.

The last application has not yet reached an average of 1 lb. a car but grows a bit each year. According to a German consultant it will eventually be more than 10 lb. to the car.

Industrial machinery parts should be a lucrative field, if only because of nylon's self-lubricating property, but it is a difficult area in which to attain volume because there is such variance of design that the market for individual pieces is not often large enough to support the relatively high cost of a mold.

Du Pont last year brought out a new formulation, Zytel 37X, with a carbon black component, designed especially to withstand weathering. It is proposed primarily as a wire jacketing material in cables, wire rope, drop wire, and tree wire but is also effective as a molding material for automotive and electrical components, marine hardware, and a wide range of sporting goods.

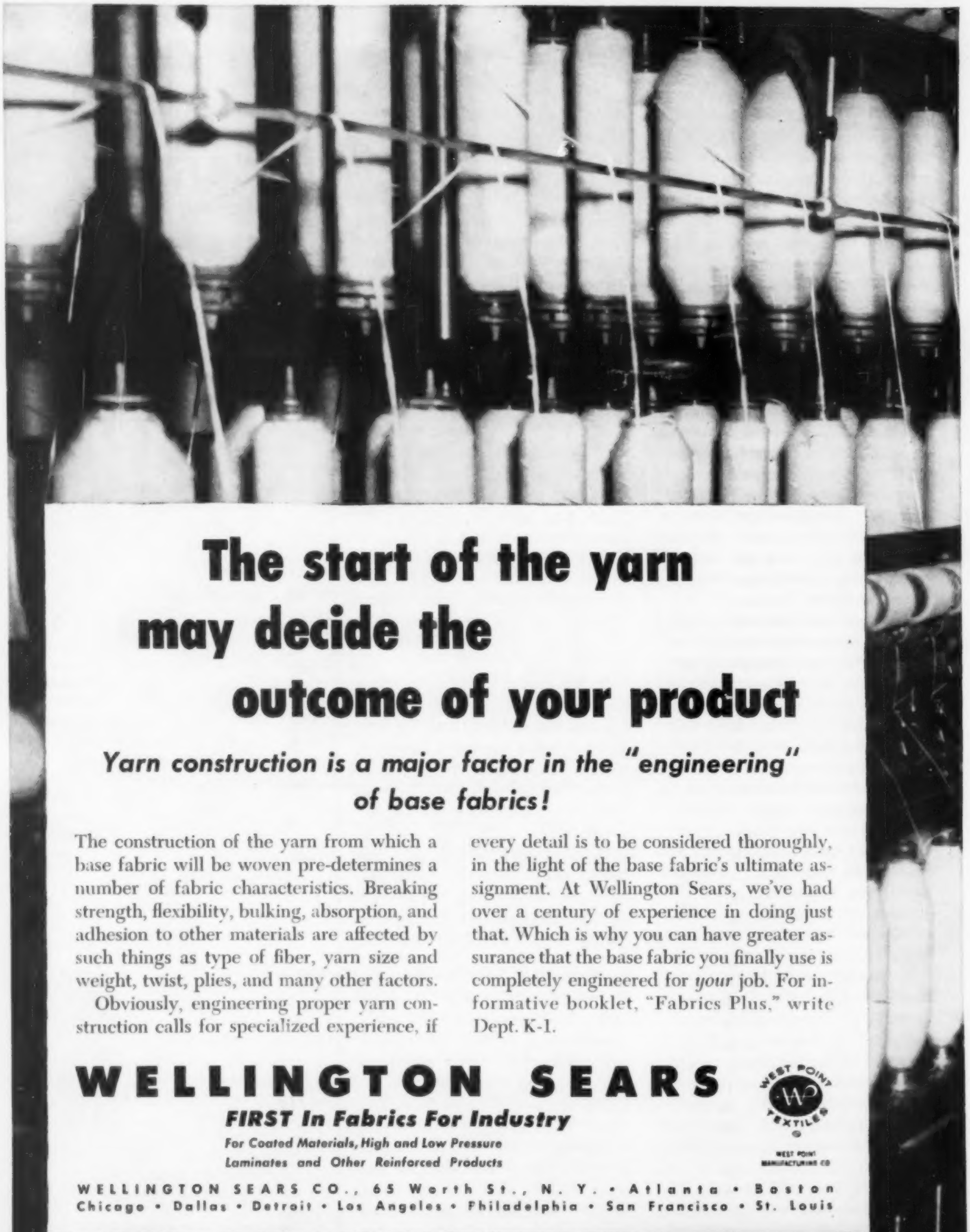
Another new formulation in 1957 was Zytel 102X, which is more white than the older materials and will be useful for combs, personal items, etc.

Zytel 42, introduced in 1956, also made good progress in 1957. It is comparable to 101, the most commonly used molding resin, but has high viscosity to provide good extrusion properties. It is now used in aerosol bottles for cosmetics because it is practically impermeable; it is also suggested for film and as a laminate on paper. Tubing with $^3/_{16}$ in. walls made from 42 is being tried for fuel lines and lubricating systems in automobiles to replace metal. It is easy to install and nylon fittings may soon be available for use with the tubing.

Another growing use for nylon, either natural or black, is for pipe fittings used with polyethylene pipe where it is now competitive on a price basis with metal fittings.

Nylon-coated wire is also claimed to be moving into the electric blanket field and the material is being used as a jacketing over vinyl in both radiant heat wiring applications and in wire used around gasoline station installations.

Du Pont alone now has 30 different nylon formulations which helps to explain why the market is expected to broaden out in many directions. But perhaps the best broadener is a price reduction, the last one of which, in September 1957, brought the price of the most generally used compounds down to \$1.18/lb. in truck load quantities. The range of prices for Du Pont's 30 different nylons is from \$1.18 to \$2.18. The latter, a compound for jacketing cables and ropes, has great resistance to impact and flexural fatigue and is somewhat superior to 63, used for similar applications where service conditions are not as severe. Then there is a textile coating resin, 61, which sells for \$1.68. Zytel 42, mentioned above, is \$1.28. But by far the most widely used materials are in the \$1.18 classification.—END



Significant trends

(*From pp.* 106-115)

of the molded-in decoration to a shape involving compound curvatures (Sept., p. 122).

Appliances

Appliances deserve mention in any review of 1957 applications if for no other reason than that they are turning out to be one of the hottest proving grounds for new materials and new processing techniques. The all-plastics refrigerator which made its debut at the beginning of the year had much to teach the industry about sandwich construction, about new adhesive-bonding systems, and about the potential inherent in plastics foam as an insulating core.

Probably the best advertising plastics materials ever had is in portable radio housings. With the appearance of housings molded of such new materials as styrene-acrylonitrile copolymers, nylon, and the new cellulosics, a note of excitement has been injected into the field. What better plug could plastics get as a tough, rugged material than the pictures that today are flooding newspapers, magazines, and TV of portable radios being dropped from helicopters or from 5-story buildings?

Furniture markets

There are three areas of activity in the furniture field in 1957 that deserve mention—the all-plastics drawer, plastics foam cushioning, and vinyl-to-metal laminates.

The plastics drawer, the industry hopes, is at last here—whether it is a compression molded phenolic drawer, a reinforced plastics drawer, an injection molded styrene alloy drawer, or a formed styrene alloy drawer (Oct., p. 114). On the basis of enthusiastic acceptance in 1957, manufacturers are already anticipating markets that can climb to anywhere from 40 to 70 million lb. of resin per year.

Seat cushions of urethane or vinyl foam seem almost a certainty in large quantities in the very near future. A good deal of promise is held out for the polyether-based urethanes which supposedly have better cushioning

qualities and a resiliency from 15 to 20% better (Sept., p. 115).

Finally, manufacturers are looking intently at the possibilities inherent in vinyl-to-metal laminates for any one of a number of furniture applications. Rumors have it that, in 1958, a complete line of bridge tables and chairs fabricated of the laminate will be made available.

Other markets

No round-up of plastics applications would be complete without showing some of the trends which are shaping plastics' future in the following fields.

Packaging: Again, as in housewares, it was the concept of low-cost disposable units that garnered most of the attention—and the automatic forming processes stood out as the key to production (May, p. 107). One manufacturer has already developed equipment for turning out 1000 vinyl closures a minute on a roll-fed forming machine. Others have developed extrusion-forming hookups capable of turning out 15,000 thin-wall styrene containers an hour.

Skin packaging and blister packaging advanced on a broad and fluid front. Automation made its presence felt in this area, too, as equipment was developed for forming, filling, and sealing blisters to cards quickly.

Film packaging also discovered hundreds of new outlets. One manufacturer even reported selling ½ million polyethlyene bags a month for packaging aspirin in three-tablet units. With the increase in convenience packaging, especially for heat-and-eat foods, Mylar-polyethylene film laminates can look forward to a big potential as a packaging material.

The more expensive luxury packages also came in for their share of plastics applications in 1957. Nylon, particularly now that such economical processing techniques as spin-welding have been developed, shows more and more potential as a material for aerosols (Aug., p. 86). Rigid formed vinyl sheet showed up in several new luxury packages, including a handsome display case for costume jewelry (April, p. 109).

Industrial: In the 1957 parade of plastics industrial applications,

tote boxes and plastics pipes and pipe components stood out. (Nov., p. 106). Extruded plastics pipe continued to move forward slowly but surely, with prime emphasis on its use in the chemical processing industry. One new area that was beginning to attract attention was the use of plastics joints for vitrified clay sewage pipes. Since 2 million tons of clay pipe are produced annually, the interest of the plastics industry in the application is understandable. Some work was done with a mechanical joint made of reinforced polyester and live rubber but the bulk of activity was directed at the possibilities in cast vinyl plastisol joints (Dec., p. 103).

Shoes: Plastics heels and other shoe components increased in volume usage in 1957 and much attention was given to the new processing techniques being developed to accommodate the special needs of this market. In England, a new type of low-pressure injection molding machine incorporating an extruder type screw was turning out shoe parts.

Transportation: The number of cars produced in 1957 was just a little higher than in 1956 and the estimated poundage of plastics used per car was similarly just a little higher than in 1956. Most of this gain was made in such applications as auto trim, which keeps on developing into a lucrative market for woven saran monofilaments, vinyl-coated fabrics, clear vinyl sheeting, and uncounted miles of stitched and extruded piping, welting, and related items (Nov., p. 112). Among the newer uses which attracted attention were foamed plastics seat topper pads, and foamed plastics automobile seat cushions (Sept., p. 115); an auto air conditioning unit formed of ABS polymer blend sheet; door panels, dashboard parts, etc., fabricated of vinyl-to-metal laminates; and a defroster distributor duct rotationally molded of the new rigid plastisols (Dec., p. 103). The concept of the all-plastics car body seems to have quieted down but in its place is an emphasis on reinforced plastics components for hardtops, hood overlays, and grilles, as styling features. (April, p. 106).—END

National technical

(*From pp.* 144-151)

will be presented showing the effect of screw speed, screw design, and extruder length on the quality and output of PVC wire coatings when dry blend is extruded.

Nylon 6 Tubing—Extrusion Techniques and Effects of Environmental and Processing Conditions on Strength, *by J. L. O'Toole, H. G. Tinger and T. R. von Toerne.* Heating the quench medium into which nylon 6 tubing is extruded improves the strength of thin wall tubing; so does annealing. The hoop strength of nylon 6 thin wall tubing drops from approximately 13,000 p.s.i. for the "bone dry" resin to 3000 p.s.i. for resin with 10% moisture content. (In average atmosphere water content is about 2.7%.) Saturation can be expressed in a mathematical form.

Teflon 100-X Perfluorocarbon Resin—A new, Melt-Extrudable Fluorocarbon Resin, *by R. S. Mallouk.* A new fluorocarbon resin is similar to TFE resin in electrical properties, chemical inertness, low permeability and excellent weatherability, and it maintains good physical properties at elevated temperature. Techniques for melt extruding wire insulation, rod and tubing are discussed.

SESSION III: INJECTION MOLDING; *Moderator, D. R. Fegley.*

Maintenance Program for the Molding Industry, *by J. C. Engman.* A complete and tested plan of action to maintain plastic production machinery and process at maximum productivity will be presented.

Wiring Diagrams—Their Purpose and How to Understand Them, *by F. R. Cinco.* Electrical circuitry and wiring diagrams all too often become the downfall of many a maintenance man or foreman while attempting to analyze a machine failure, make additions, or effect modifications. This paper will point out how relatively simple the reading of a wiring

diagram can be if it is compared to a circuit with which everyone is acquainted.

Automatic Injection Molding, *by Q. M. White.* Two concepts of automatic molding will be presented. Automatic machines and conventional molds will be compared to conventional machines with automatic molds. Engineering and cost comparisons will be made of the two concepts.

Injection Molding by Automatic Means at Kodak, *by L. Ulmschneider.* A film and paper will portray complete automatic molding from the material barrel to the inspection station. The injection machine, mold, and accessory equipment will be covered.

SESSION IV: FOAMS; *Moderator, R. H. Kittner.*

New Developments in Vinyl Foam, *by H. E. Allen.* Recent radical improvements in vinyl foam technology and fabricating techniques will increase market potential. Reduced density possibilities and aging test data will be discussed.

Properties of Urethane Foams, *by J. H. Saunders.* The mechanical properties of urethane foams produced from polyesters and polyethers will be compared with each other and with latex foam.

New Room Temperature Setting, Heat Resistant, Low Density, Silicone Foams, *by D. E. Weyer.* Four new silicone foams for lightweight, high-temperature thermal insulation will be introduced to the plastics industry. Two of these room-temperature-curing foaming resins cure to rigid or semi-rigid fine-celled structures with densities of 4 to 5 lb./cu. ft., can be used continuously at 650° F. The other two cure in a few minutes to foams having densities ranging from 5 to 13 lb./cu in., that are flexible and resilient at temperatures from —65° to over 500° F.

Epoxy Resin Foams, *by M. H. Nickerson.* Production methods, physical and chemical properties of epoxy foams will be covered. Also material on specific applications to sandwich construction and model building will be included in the paper.

Friday morning

SESSION I: COMPRESSION MOLDING; Moderator, *S. H. Greenwood.*

Compression and Transfer Molding of Epoxy Compounds, *by W. J. Dewar.* Effects of various fillers on properties, cure time and pressure relationships, various epoxy hardener systems and ejection problems will be discussed.

Automatic Preforming of High Impact Phenolic Materials, *by M. E. Lawrence.* Fluffy, high-impact phenolic materials can be machine preformed without manual operations in a horizontal type preforming machine that cuts high-impact-compound weighing

and preforming costs by up to 90 percent.

Properties Required for Automatic Compression Molding of Thermosetting Materials, *by F. J. Donohue.* Faster curing, and special preheating properties can be provided. Uniform powder feed, excellent mold and flash discharge as well as rigid set on discharge are other desirable properties which will be discussed.

The Development and Application of Automatic Preheating of Thermosetting Powders, *by D. C. Amsler.* Automatic preheating requires special hoppers and loading boards and is best suited for long running, high production applications. The economies will be shown to be worthwhile.

SESSION II: SHEET FORMING; *Moderator, D. A. Davis.*

Technical Aspects of Postformable Decorative Laminates, *by A. V. Dupuis.* Process variables affecting postformability and a newer test for evaluating this property of high-pressure decorative laminates will be discussed.

Theoretical Aspects of Vacuum Forming Thermoplastic Materials, *by L. Dreifuss.* The structure and physical properties of thermoplastic materials will be discussed and how these properties are influenced by the vacuum forming process.

Extrusion and Vacuum Forming of Polyethylene Sheet, *by A. L. Griff, H. F. Tomfohrde, III, and E. E. Griesser.* The equipment and techniques for extrusion and vacuum forming various types of polyethylenes including regular and linear types, will be discussed.

Advancements in Continuous Vacuum Forming Processes, *by M. J. Kalahar.* The advantages, limitations, economic aspects and future potential of this process will be explained. Slides will illustrate this technique and in line trimming of thin-walled containers.

SESSION III: NEW MATERI-

ALS—III; Moderator, W. O. *Bracken.*

Embrittlement of Polyethylene, ***by C. S. Imig.*** The higher-density polyethylenes tend to embrittle after continued exposure to temperatures somewhat below the crystalline melting point, because of growth of the crystallites and/or polymer degradation through oxidation. Resistance to heat embrittlement was found to be better with lower melt index, higher molecular weight resins. In injection molding, higher stock temperatures were found to improve the resistance of a material to heat embrittlement.

Environmental Stress-Cracking of Polyethylene Injection Moldings—Practical Control and Test Methods, ***by R. J. Anderson and S. R. Melvin.*** Methods for increasing stress cracking resistance of polyethylene moldings, and practical procedures for specific item testing.

Some Tensile Properties of Fractionated Low-Pressure Polyethylene, ***by L. H. Tung.*** The influence of molecular weight on the tensile properties of low-pressure polyethylenes has been studied by measurements of fractionated samples. Some of the data will be presented.

Early Detection of Weathering Damage in Polyethylene, ***by J. W. Tamblyn, G. C. Newland, and M. T. Watson.*** Results will be presented to show that colorless stabilizers are available which will satisfactorily protect polyethylene against breakdown by weathering.

SESSION IV: RHEOLOGY; *Moderator, E. A. Haddad.*

Historical Introduction to the Rheology of Plastics, ***by E. T. Severs.*** Quantitative studies of the flow properties of plastics are rapidly changing the art of processing into a science. This paper outlines some major fields measurements.

Rheology of Intensive Mixing—I, ***by J. T. Bergen, G. F. Carrier, and J. A. Krumhansl.*** Criteria for mixing and the mixing process. A generalized analysis of the mixing process in a laminar flow system is derived from which several criteria for mixing are derived. Application of these conclusions is illustrated for a simple experimental mixing device and a commercial mixer.

Rheology of Intensive Mixing—II, Flow in an Intensive Mixer, ***by W. R. Bolen and R. E. Colwell.*** Theory of flow in an intensive mixer will be presented to provide a basis for computations in mixing problems.

Rheological Considerations in Plastics Product Design, ***by B. Maxwell.*** Methods of determining flow and deformation properties of plastics at use conditions will be discussed together with the significance of these properties to proper engineering design of plastics products. Test data on PVC, polyethylene, and polymethyl methacrylate are presented.—END

The year 1957

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The Plastiscope

News and interpretations of the news
By R. L. Van Boskirk

Section 2 *(Section 1 starts on p. 37)*

Alkyd-glass molding material

STRalkyd, a general-purpose glass-reinforced alkyd molding compound, has been developed at the thermosetting plastics laboratory of Panelyte Div., St. Regis Paper Co. The company states that the compound, available in molded shapes only, is designed to compete not only with phenolics, ureas, and melamines, but also in those areas served exclusively by metals in the past. It combines surface smoothness, color, and gloss, with high strength, good electrical properties, flame and arc resistance, and high heat resistance.

STRalkyd is claimed to be suitable for structural items and housings for radios, TVs, and small appliances, where good surface appearance, permanent color, and high-impact strength and rigidity must be combined with light weight. Other uses anticipated include switch-gear moldings; high voltage aircraft insulation; replacements for die castings; and ceramic applications.

The compound is being molded at the Dexter, Mich., plant of Michigan Panelyte Molded Plastics, Inc. and the company's Trenton, N. J., plant. Compression molding facilities, including 1500-ton molding presses and preform equipment, have been installed at Trenton. This marks the company's first entry into compression molding in the East.

Resin for rigid urethane foam

Polyester foam resin R-42, used to make rigid urethane foams for heat insulation and soundproofing, is now being offered by Du Pont's Finishes Div. under the name "Dulux." According to the company, the resin is capable of being foamed-in-place to form an integral part of the structure, with good strength, good aging characteristics, high moisture resistance, and excellent insulation properties.

The material has been evaluated in one-shot and semi-prepolymer formulas; the latter method appears to provide slightly better control, more closed cells, and a more uniform cell structure. Laboratory data of foams made by the semi-prepolymer technique describe a 2-lb. density foam as excellent in humidity aging characteristics, possessing tensile strength of 75 to 85 p.s.i., and having a *K* factor of 0.23 to 0.30.

Spray guns are now available that will lay down films which will expand to produce insulation at the rate of 50 to 60 board feet per minute. Du Pont states that low-density foams can be prepared at an ingredient cost of less than 6¢ a board foot, using the R-42 resin.

*Reg. U.S. Pat. Off.

Consoweld takes over Richardson's decoratives

The decorative plastic laminate customers of The Richardson Co., Melrose Park, Ill., will henceforth be supplied by Consoweld Corp., Wisconsin Rapids, Wis., according to an announcement by J. G. Somers, general manager of Consoweld. This action is the result of Richardson's decision to discontinue the manufacture of plastic decorative laminates in order to expand its production of industrial laminates.

Consoweld has purchased Richardson's decorative materials inventories which will be transferred to its new 18,000-sq. ft. warehouse.

Richardson's decorative plastic laminate has been marketed under the tradename Richelain and sold primarily to dinette and furniture makers. Consoweld's production is devoted primarily to the manufacture of decorative plastic laminates which are sold through a national distributor organization and directly to furniture, dinette, and other manufacturers.

James D. McGregor, formerly decorative sales manager of Richardson, is now manager of furniture sales at Consoweld. He will be assisted by Joseph H. Johnston, who was also formerly associated with Richardson.

Metallized nylon

Base and top coats used in metallizing molded nylon parts are now available from Vacuum Coatings Div., Industrial Solvents & Chemicals, Inc., Wilkinsonville, Mass. The top coat can be air-dried, has good adhesion, gives a mirror-like reflection, and does not embrittle the nylon. Finished parts can be dyed, if desired.

The coatings are particularly suggested for blown nylon bottles.

New careers for retired

A group of retired technical and executive personnel, most of whom were previously associated with Hercules Powder Co., has formed J. B. Wiesel & Associates, 1001 Overbook Rd., Westover Hills, Wilmington 6, Del., as management consultants, thereby providing one answer to the problem of utilizing the experience of persons who have reached the retirement age of 65 but have not outlived their usefulness to industry.

Members of this group held the following positions with Hercules: J. Boiseau Wiesel—director of technical sales service; J. Leroy Bennett—department manager, chemical operations, Explosives Dept.; Volney R. Croswell—manager of Naval Stores and Papermakers' chemicals plants; Jo-

seph M. McVey—personnel director; Oscar A. Pickett—manager of technical literature; C. Harlow Starks—control supervisor, Cellulose Products Dept.; and Hugh F. Wendle—project engineer. Also associated with the new company are F. H. Lang, formerly superintendent in charge of lacquer production of Sherwin-Williams Co., and John H. McCall, formerly vice president of Connecticut National Bank.

Finish for polyethylene

A coating claimed to provide a hard gloss and glassy finish to all types of polyethylene has been developed by C. L. Rowe Corp., 61 Van Dam St., Brooklyn 22, N. Y. Designated Amiloc, the product reportedly increases clarity, has good adhesion, flexibility, scuff resistance, is a good gas barrier, resists a wide range of active solvents and can be applied by conventional methods, such as spray or dip.

Amiloc can be tinted to almost any shade, is compatible with metallic powder, and can be used either as a lining or top coat for decorative purposes or to protect printed designs.

Exchanges know-how

A cross-licensing agreement, calling for an exchange of technical information, know-how, and formulas for chemical intermediates, has been completed between Catalin Corp. of America and Société Francaise D'Organo-Synthese, one of several technical and commercial chemical firms comprising the Roger Bellon Enterprises of Neuilly-Paris, France. The company is an important factor in France in the production of organo-synthesis chemicals for the plastics, rubber, textile, petroleum, pharmaceutical, beverage, and cosmetic industries.

This agreement is Catalin's third step in achieving international recognition and distribution of its products. Last June, a five-year contract for exchange of technical information was signed with Adhesivos Resistol, S.A., Mexico; in October, a similar agreement for the production of one- and two-stage phenolic resins was concluded with Cie Centrale Rousselot, Paris.

Equipment show

The annual national convention of the National Association of Plastic Fabricators was recently held in Los Angeles. Members of the association, all of whom are fabricators of decorative plastic laminate products, or suppliers of material and equipment used in the industry, expressed a universal note of enthusiasm for the 1958 outlook. Delegates from all parts of the United States held discussions on various manufacturing methods, estimating, cost reduction, and labor and management relations.

As a follow through to the "how-to-do-it" session of the program, a display of fabricating equipment was staged at Tri-State Distributing Co., where electronic wood welding and bonding equipment, post-forming machines, shop saws, contact cements, portable power tools for fabrication and installation, and plastic laminate samples were exhibited.

Among the offerings at the exhibit was a folder distributed to visitors which described the activities and aims of NAPF and its local chapters, and informed the public of the increasingly important part that laminated plastic products have come to play in many diversified fields.

Hot-melt adhesive

Assembly line operations, particularly for holding small parts in place until they can be permanently fastened, are simplified by Ray-Bond D-84001, a hot-melt adhesive developed by the Adhesives Dept. of Raybestos-Manhattan, Inc., Bridgeport, Conn.

The adhesive is said to provide instant grab when applied to etched Teflon, Mylar, polystyrene, polyethylene, glass, and almost any other material.

Composed entirely of solids, the adhesive is supplied in a semi-brittle state. It is liquefied by heating to 250° F. and applied in the fluid state to one of the parts to be assembled. The other part is immediately pressed into contact and the two held together until the adhesive cools. The strength of the bond increases as the adhesive cools to room temperature.

According to the company, Ray-Bond R-84001 may also be used as a permanent binder, provided that temperatures do not exceed 150° F. A 1-sq. in. lap joint made with strips of Mylar will hold a dead load of 50 lb. at 73° F. and a load of 6 lb. at 150° F.

It is reported that the adhesive may be kept at 250° F. without deteriorating. However, for continuously operating assembly lines, it is advisable to heat only enough for an 8-hr. period.

Polyester for urethane

A modified glycol-polyadipate, specifically designed for reaction with di-isocyanates to produce urethane flexible foams and films, is being offered by Rubber Corp. of America, Hicksville, N. Y. Designated RC Polyester F-1, it is suggested for either prepolymer or straight blending formulations.

Mylar for outdoor use

The new, weatherable-type Mylar polyester film, recently announced by Du Pont, is claimed to withstand direct exposure to sunlight for extended periods. An outdoor life for the film (in 5-mil thickness) of approximately five years is estimated on the basis of accelerated tests and Florida exposure.

Because of its tensile strength, clarity, and durability under extreme temperatures, one of the most promising uses seen for weatherable Mylar is in the construction of greenhouses. Greenhouses made with a double wall of the film and a simple frame have been constructed (including labor and material) for 50¢/sq. ft. First-quality commercial greenhouses, using glass, cost an estimated $2/sq. ft. to build.

Du Pont states that a number of companies have shown interest

The Plastiscope

in weatherable Mylar for air-supported structures since its strength permits use of thin film. Units now are in use as swimming pool covers, greenhouses, and temporary construction buildings.

A 1-mil thickness of the film, laminated to various backings, appears promising as a weatherable surfacing material for decorative and trim applications. Storm windows, breezeway enclosures, patio roofs, and glazing for poultry houses and farm buildings are other possible applications.

Initial price of 5-mil weatherable Mylar film for development purposes is expected to be approximately \$3.25/lb., or 11½¢/-sq. ft.

Development quantities are now available. Plans are under way for commercial production, expected some time early in 1958.

New A.S.T.M. district

The first session of the new Four Corners District of the American Society for Testing Materials will be held at Albuquerque, N. M., on January 27. The new district represents the states of New Mexico, Arizona, Utah, and Colorado.

Some of the papers to be presented will be "Accelerated Aging Tests and Life Aging Properties of Aircraft Metal Adhesives," "Testing for Mold and Fungus Resistance of Materials in Storage," and "Materials for the Year 2000."

Those interested may write to J. L. Abbott, 1902 Richmond N.E., Albuquerque, N. M.

Completes a half century

Nopco Chemical Co., Harrison, N. J., producer of urethane foam, processing chemicals, stabilizers, mold lubricants, metallic soaps, etc., is celebrating its 50th anniversary as a chemical manufacturer.

The company, one of the first to enter the urethane foam field, has developed a machine, called the Nopcometer, for foaming-in-place of rigid and flexible urethane formulations. It is available on a lease basis, with Nopco supplying the technical training.

A new plant was constructed in N. Arlington, N. J., which is said to have a production capacity of over 5 million lb. of foamed plastics annually.

Sells controlling interest

A group of investors, headed by C. H. Lockton, Westport, Conn., has purchased the controlling interest in the stock of New England Laminates Co., Inc. from Eastern Industries, Inc., Hamden, Conn., according to an announcement by John E. Currier, president of Nelco. Mr. Lockton assumes the post of treasurer and board chairman of Nelco.

Nelco, which was formed over two years ago, is engaged in the printed-circuit industry as a supplier of metal-clad laminates for radio, television, computors, guided missiles, and other electronic components. The changeover makes available to Nelco substantial amounts of new financing which will enable the firm to expand its facilities with new processing equipment.

Process for prototypes

Prototypes and small parts, where the production run is low and will not justify expensive production tools, can be manufactured by a process developed by Western Tool & Mfg. Co., Springfield, Ohio, using a special polyester compound, IC-1218, made by the Finishes Div. of Interchemical Co. The compound, which contains an inert filler, pigments, and milled glass, is either poured into an open mold for encapsulating or injected into a die. The molds and dies can be made from plastics, plaster, cast alloys, ceramics, and other materials.

The company reports that parts are equivalent in many respects to cast or molded phenolics. The low tooling costs and reasonably short cure cycles make the process and material suitable for short runs.

The polyester compound has a neutral color, but pigment paste can be added if necessary.

Heat seals urethane foams

Bonds that are at least as strong as the material itself are said to be possible for both polyester- and polyether-type flexible urethane foams by using dielectric sealing equipment manufactured by Dynatherm Div., Guild Electronics, 388 Broadway, New York 13, N. Y. The process does not involve heating materials first and thus permits economical fabrication, including embossing and tear-sealing from slab stock. Successful dielectric sealing of urethane to itself and to other materials will considerably extend the fields of application of these foams. According to the company, heat-sealing of vinyl foam is also possible with the same equipment.

Buffing compounds

Three new buffing compounds for plastics have been added to the line of Hanson-Van Winkle-Munning Co., Matawan, N. J. They are PC-19, developed specifically for acrylics; PC-52, a medium or heavy cutting compound with a built-in lubricant to minimize burning or roll-over, said to be suitable for most plastics; and PC-93, designed for high color work on all plastics, except nylon. It produces especially high color on styrene, acetate, and butyrate.

The compounds contain a special anti-static ingredient which eliminates dust and debris pickup by freshly buffed plastic. They are said to eliminate the necessity of special rinses or handling between buffing operations. The compounds are available in bar sizes for both manual and automatic application.

Free PVC pipe tests to stop

The Bureau of Ships, Department of the Navy, intends to change the cost allocation of qualification tests for Specification MIL-P 19119, Pipe, Plastic, Rigid Unplasticized High-Impact Polyvinyl Chloride. The terminal date

POLYETHYLENE PROCESSING TIPS

U.S.I.

Vol. III No. 1

PROCESSING CONDITIONS AFFECT STRESS-CRACK RESISTANCE OF POLYETHYLENE PRODUCTS

Most thermoplastic materials are subject in varying degrees to environmental stress-cracking . . . and polyethylene is no exception. Stress-crack failures may occur in polyethylene when the plastic is under high local stresses, either externally or internally applied, and in contact with soap, detergent or solvent.

Stress crack resistance depends on the resin used, and the processing conditions. The effect of polyethylene resin properties were discussed in the last issue of TIPS. This issue will be devoted to the effect of processing conditions.

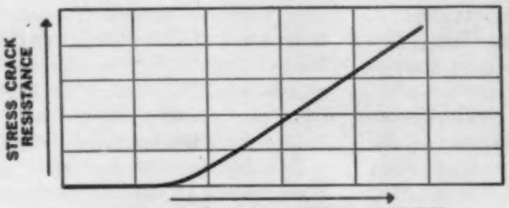
Apart from outside forces, there are, for a given polyethylene resin, two main causes of stress-cracking: locked-in stresses, and a high degree of molecular orientation. Locked-in stresses arise from uneven shrinkage during cooling. In molecular orientation, polyethylene molecules are comparable to iron filings in a magnetic field; they line up in force or stress patterns which, in effect, are stress concentrations along which fractures may occur.

Mold design affects stress cracking

To improve the stress-crack resistance of molded polyethylene, the molder should select his resin carefully on the basis of mold design, injection and mold temperatures, and, of course, the properties he wants in his end product.

Here, for example, is one way in which mold design can influence the choice of a resin: It is *generally* true that resins of higher molecular weight have relatively high stress-crack resistance. But in deep-draw molded items, or those with large cross-sections, resins of low molecular weight often yield a product with better stress-crack properties. This is because resins of low molecular weight—and hence, lower viscosity—permit the mold to fill more quickly. Under these conditions the material cools at a more uniform rate and fewer internal stresses are created.

Different flow rates, due to abrupt changes in mold cross-section or to sharp corners, may create points of stress concentration. These cannot always be eliminated, since every design is a compromise between mold engineering and product design.

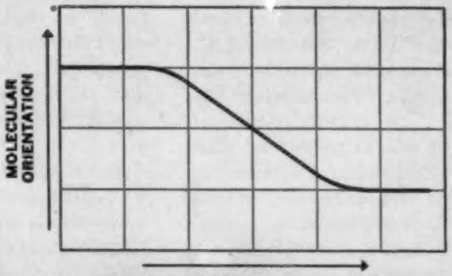


Stress crack resistance increases with higher stock temperatures in injection molding.

How Cold the Mold?

Higher production rates, made possible by running a cold mold, may be offset by a high incidence of stress-crack failures due to molecular orientation. This difficulty may be minimized by using a resin with the right flow properties—always bearing in mind that a practical compromise must be made with other desired end properties. Molecular orientation occurs when the hot resin comes in contact with the relatively cool walls of the mold. The outer surface of the stream cools faster than the interior and tends to slow down, while the material nearer the center flows unimpeded. The molecules tend to line up in the direction of flow.

This difference in cooling rates between the material at the periphery of the stream and its center also sets up internal stresses which induce stress-crack failures.



Molecular orientation is decreased with higher stock temperatures.

Mold Release Agents have some effect

Mold release agents may be of some benefit, as they tend to reduce the "drag" effect. However, caution must be used in their selection, since certain materials may induce stress cracking.

Compromise is often necessary

While no simple answer exists to the problem of stress-cracking in polyethylene products, resistance can usually be brought to a satisfactory level by choosing the best resin, making adjustments in molding temperatures, cooling rates and mold design. Since certain compromises must always be made, in selecting a resin and in processing techniques, processors can frequently use the services of a resin specialist. U.S.I.'s Technical Service Engineers are ready to discuss your processing problems, and to help in every way to solve them.

for receipt of requests for tests at Government expense is February 28, 1958. Qualification tests requested after that date will be at the manufacturer's expense.

Copies of the specification may be obtained from the Commanding Officer, Naval Supply Depot, Scotia 2, N. Y.

Urethanes for potting

Solid and cellular urethanes for potting and encapsulation of electrical and electronic assemblies are possible with compounds based on Nacconate diisocyanates produced by National Aniline Div., Allied Chemical & Dye Corp., New York, N. Y.

Solid urethane potting compounds are characterized by high dielectric strength, low dielectric constant, and low moisture absorption. Corrosion resistance of the resins is said to be such that they can be used in environments involving exposure to strong acids, alkalies, oils and gasoline, and aliphatic solvents. They possess a low power factor and can withstand heavy shock at low temperatures, according to the company.

Cellular urethane potting compounds are lightweight, around 2 lb./cu. ft., which is important when large assemblies are encapsulated and the weight of the finished unit is critical. They also require only short cure-time.

Windsor expansion

R. H. Windsor, Ltd., London, England, will soon start manufacturing machinery for plastics processing in Australia under the name of R. H. Windsor (Australia) Pty. Ltd., with its head office in Melbourne. The firm has also established a subsidiary in Canada—R. H. Windsor of Canada, Ltd.—with its main office in Toronto. Windsor produces five models of extruders and 12 types of injection machines.

L. J. Herman & Co. Pty., Ltd. will manage the Australian firm. Arthur G. Dennis, LL.M., chairman of R. H. Windsor, Ltd., has been named chairman of the Canadian subsidiary; and R. E. G. Windsor, managing director of the parent company is president.

Profits for the year ending March 31, 1957 for R. H. Windsor, Ltd., of London, amounted to $294,000 as compared with about $197,295 for 1956 and $15,545 for the year ending March 31, 1953.

Sixty percent of the company's production is exported from England.

Unplasticized vinyl film down

Glass clear, calendered, unplasticized PVC film, produced by Anorgana G.m.b.h., Gendorf, Bavaria, has been reduced 5% after about 18 months in commercial production. It was also announced that the firm's new calender will produce this film up to about 48 in. wide.

The Plastics Div. of Anorgana is represented in the United States by David S. Greenfield, 3143 Decatur Ave., New York 67, N. Y. According to Mr. Greenfield, this PVC film is available in two types for deep drawn packages or blisters, each in several thicknesses: Type L for foodstuffs and Type T for technical grade.

The new price, varying inversely with the thickness, ranges from 71¢ to 82¢/lb., F. O. B. Hamburg. All of Anorgana's hard PVC films are sealable.

Increased polyester production

In conjunction with plans for a multi-million-dollar expansion program, American Petrochemical Corp. is installing two 50,000 p.p.d. polyester resin reactors at its Mol-Rez Div. plant in Minneapolis, Minn.

Heat, viscosity, speed of operation, and horsepower changes for the giant reactors are all electronically controlled. The reaction chambers, constructed of ⅜-in. stainless steel, are so large that they were made in two halves and welded together. Solvents are fed to the reactor by metering pumps which adjust automatically to temperature and specific gravity changes.

Mol-Rez manufactures a variety of copolymers but specializes in polyester-type resins, of which it now lists 43 types. A sister division, Midwestern Color Works, specializes in color dispersions for polyester resins.

Plastics Technology courses

The Special Courses Div., Newark College of Engineering, 367 High St., Newark, N. J., in cooperation with the local section of Society of Plastics Engineers, Inc., is offering the following courses in plastics technology: Compression and Transfer Molding, to be held on Thursdays, starting January 9; Plastic Mold Design, Tuesdays, starting January 7; and Thermoplastic Process Techniques, Mondays, starting January 6.

The term for each course is 12 weeks. These courses form part of the certificate program in Plastics Engineering Technology.

PVC valves save maintenance

Molded Luncor PVC valves, manufactured by Lunkenheimer Co., Cincinnati, Ohio, are reported to have given two years of trouble-free service at Halby Chemical Co., Wilmington, Del. The valves employ traditional Y-type body design, minimizing flow resistance and assuring positive shut-off. The packing nut features a built-in gland wtih self-lubricating Teflon packing. The valves, with screw or socket ends, are rated at 125 p.s.i. water at 140° F.

Intermediates for synthesis

Methyl butenol and methyl hydroxy butanone, derivatives of methyl butynol, are now available in development quantities from Air Reduction Chemical Co. Methyl butynol will be commercially available early in 1958 when the company's new plant at Calvert City, Ky., goes on stream.

The two derivatives have a wide variety of uses as intermediates in the synthesis of plastics, pharmaceuticals, perfumes, etc., and are suggested as solvent additives. Methyl hydroxy butanone is also suggested as an ul-

tra-violet screener for use in plastics, furniture, textile and leather finishes, etc. to protect against light degradation.

S.P.E. lectures

The reinforced plastics group of the Detroit Section of Society of Plastics Engineers, Inc., has begun a new series of programs, following the success of last year's meetings. Future subjects announced are "Resins for Tooling," "Surface Coatings and Conditioning to Weathering of Laminates," and "Foaming Resins."

The group will meet every fourth Monday of the month through April.

George Wadtke is chairman of the group; Walter M. Stark, 16147 Meyers Rd., Detroit 35, Mich., is program chairman.

Plasticizers for cellulosics

On page 99 of the 1957 issue of MODERN PLASTICS Encyclopedia, in the article on Cellulosics, a statement was erroneously printed to the effect that "cellulose propionate requires less than half the plasticizer needed to produce cellulose acetate butyrate of comparable flexural strength." Actually, the statement should have referred to plasticizers for cellulose acetate and not cellulose acetate butyrate.

Findings have indicated that in the case of both propionate and butyrate, plasticizers are present to the extent of up to 35 parts per 100 parts of cellulose ester. In the case of cellulose acetate, findings seem to indicate that plasticizers are present to the extent of 10 to 70 parts per 100 parts of cellulose acetate.

Expansion

Reichhold Chemicals, Inc. announces the purchase of a large tract of land at Hampton, S. C., to build its fourteenth U. S. plant. The first units to be constructed will be a large methanol terminal and facilities to produce 30 million lb. of formaldehyde annually. Commercial production is expected to be under way by about July 1958.

A number of new plants are scheduled for the production of formaldehyde and pentaerythritol, as well as for the manufacture of other products which involve methanol or formaldehyde in their production.

Celanese Corp. of America has started construction on a new manufacturing unit at its Belvidere, N. J., plant to increase production of polyvinyl acetate emulsions which are now manufactured at the Linden, N. J., plant.

Production of these emulsions is a new activity for the Belvidere plant, which already turns out cellulose acetate and cellulose propionate molding powders and cellulose acetate extruded and cast film.

Michigan Chrome & Chemical Co. has broken ground at its Detroit, Mich., plant for the addition of an 18,000-sq. ft. laboratory. The building, scheduled for occupancy by March, will provide facilities for the **Plating and Chemical Divs.** which will be devoted to plating control, new product research, chemical products development, and technical service. A plating pilot plant and a chemical pilot plant will be included.

Dr. R. M. Lacy is technical director; **A. C. Lansing,** laboratory manager; and **Hans K. Neumann,** research supervisor.

Bolta Products Div., The General Tire & Rubber Co., Lawrence, Mass., announces that its new custom-built calender for the production of plastic sheeting is now in operation. According to a company spokesman, the calender is capable of operating at higher temperatures than any calender heretofore available. It is capable of producing 12,000 yd. of vinyl sheeting per hour. The total output of the company could double these figures since the firm now has two separate calenders in round-the-clock operation. It was estimated that the combined facilities could turn out as much vinyl upholstery material as the entire industry produced some eight or 10 years ago.

A major feature claimed for the new calender is its exceptional temperature range which can be raised at least 200 degrees above that of any calender now being used. This factor permits superior quality in rigid sheeting which has a tendency to fight temperature and hence requires extreme heat in order to provide maximum tensile strength, abrasion resistance, and longer life. The higher temperature range is also said to permit the handling of resins and other material that previously could not be calendered. The calender was designed by Bolta engineers and built by **Farrel-Birmingham Co.**

Flambeau Plastics Corp., Baraboo, Wis., has started construction on a $260,000 structure which will include office, manufacturing, assembly and finishing, and warehouse space, as well as the tooling division. Occupancy of the new facility is scheduled for May 1.

The company manufactures a line of housewares, premium items, and advertising specialties; its **Custom Molding Div.** produces products for companies throughout the country.

Allied Chemical & Dye Corp. has opened a new warehouse at 6510 Bandini Blvd., Los Angeles, Calif., consolidating the activities of its **General Chemical, National Aniline, and Barrett Divisions.** The building is equipped with handling and storing facilities for dry and liquid chemicals, resins, and dyestuffs.

The regional sales offices of Barrett and National Aniline Divs. will also occupy special quarters in the building; General Chemical's sales office will remain at 2999 W. 6th St.

Owens-Corning Fiberglas Corp. is establishing a Pioneering Laboratory west of Granville, Ohio, which will be devoted to long-range development projects that have significant potentials in fields related to fibrous glass. The new laboratory will operate independently of the firm's Basic and Applied Research Laboratory at Newark, Ohio, and the Divisional Product and Process Development Laboratories.

Games Slayter, research and development vice president, has been named director of the lab-

(*To page* 259)

Monsanto *Polyethylene* Resins

—formulated for the toughness that satisfies ...and sells!

Toughness that means fewer film rejects... tougher film that takes the roughest handling without tearing . . . toughness that opens up more and more uses for polyethylene film. This toughness that means customer satisfaction starts with special tough-grade polyethylene resins developed by Monsanto research.

Monsanto special tough-grade polyethylene resins are available for extruding and calendering film. Other special formulations have been developed for wire and cable insulation, extrusion coating, tubing, profile shapes, and moldings.

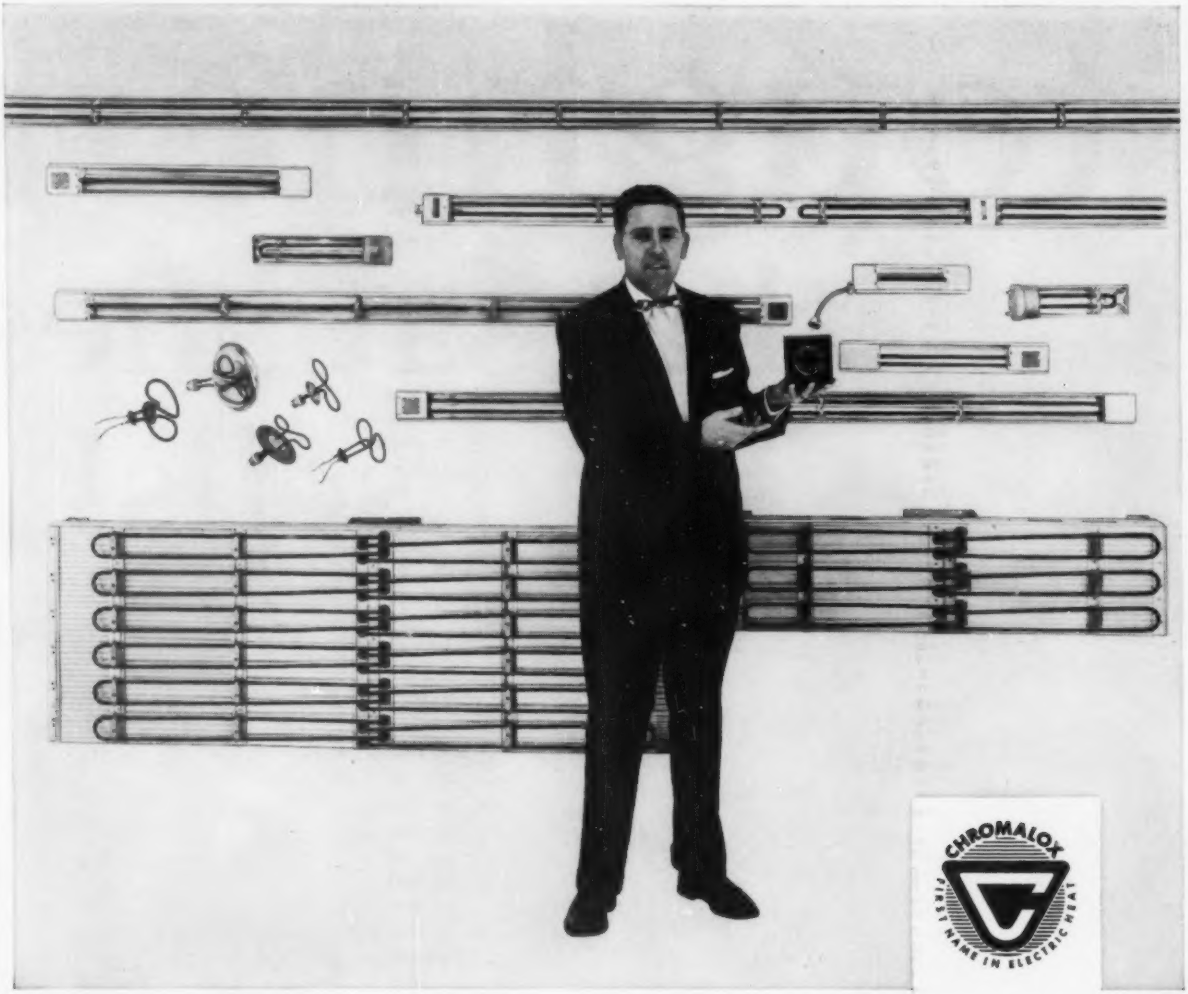
Write for detailed information to Monsanto Chemical Company, Plastics Division, Room 1772, Springfield 2, Mass.

MONSANTO

TOUGH-TESTED

At Monsanto Research and Testing Laboratories, a weight-loaded dart is repeatedly dropped on film extruded from Monsanto Polyethylene resin. This is one of many tests to maintain the highest levels in toughness for packaging and other uses.

New heating problem? Old production headache? ℞: Far-Infrared



Call the Chromalox man for the **ANSWERS**

At his fingertips, your Chromalox Representative has the answer to production delays, irregular product quality and other common problems caused by complex, outmoded heat sources. Chromalox Electric Far-Infrared radiation can be simply and precisely controlled over largest work areas, and is absorbed uniformly by practically all colors—even optically transparent materials.

With this fast, uniformly distributed heat, generated right at the job site, there is no need for stand-by heat or leaking lines. No smoke, fumes or flames. No glare. It's cooler and cleaner for your workers, too. Chromalox Far-Infrared elements are self-cleaning. Maintenance costs are minimum, as the all-metal heaters are practically indestructable—have no moving parts.

Get the best answers to all your heating problems. For assistance on new installations, or on improving an existing system, call or write your Chromalox Sales Engineering Representative. Standard heaters, to fit most jobs, are ready for immediate shipment from the world's largest stock. What's more, your Chromalox Representative offers factory design-engineering service for special applications. He has the electrical answer that's fast, clean, safe, accurate and economical.

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The Plastiscope

oratory. **Dr. A. C. Siefert** will continue as director of the Fiberglas Basic and Applied Research Laboratory, reporting to the president. **Dr. L. P. Biefeld,** formerly technical director on the research and development staff at Newark, has been appointed to the newly-created post of technical assistant to the president at Toledo.

Witco Chemical Co., Canada, Ltd. is constructing a new plant southwest Toronto for the production of metallic stearates. The plant is expected to be completed early in 1958 and marks the first step in the firm's plans for manufacturing facilities.

The Canadian company is negotiating for a license from **Witco Chemical Co.,** New York, N. Y., entitling it to use the Witco name and production know-how.

Tappan Stove Co., Mansfield, Ohio, has entered into an agreement to acquire the entire stock of **Champion Molded Plastics, Inc.,** Bryan, Ohio, supplier of plastics components for the refrigeration and air conditioning industries and manufacturer of plastics parts for automobiles and radio and television receivers, plastics toys, and hardware. This is part of Tappan's diversification program which began in 1955 when the company entered the electronics field with the introduction of the first electronic range for the home.

The firm states that although Champion's present production facilities are not immediately adaptable to the manufacture of plastics components for Tappan ranges, it expects to utilize Champion's experience in plastics in its program of research and development on cooking appliances.

Champion's founders will continue to manage the company under Tappan's ownership.

The Richardson Co. will increase its production facilities for the firm's line of Insurok industrial laminated plastics at two of the company's six plants—Newnan, Ga., and Melrose Park, Ill. At Newnan, the manufacture of decorative laminates will be soon discontinued to prepare for increased production of industrial laminates. Installation has been completed at Melrose Park of the latest type phenolic saturator, capable of processing rolls of base laminate materials in widths up to 50 in., and a new 12-opening laminating press which can laminate sheets 50 by 54 inches. The press has a monthly production capacity in excess of 100,000 pounds.

Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y., manufacturer of thermoplastic molded parts and miniature die castings, has started an expansion of its plant and production facilities which will more than double the firm's output. The expanded plant, which will aggregate over 150,000 sq. ft. of space, is expected to be completed in the spring of 1958.

The company asserts that last year it turned out more than 1 billion parts, molded or die-cast. Products include fasteners, consumer hardware, miniature gears and pinions, etc.

Plastic Factors, Inc. has quadrupled its working space by moving from San Carlos to 926 Broadway, Redwood City, Calif. The company predicts that additional equipment will now make it possible to surpass last year's production of over 500 different plastics items. Development of the firm's own brand name products for western distribution is also a part of the expanded program.

The company is engaged in designing, engineering, molding, fabricating, and vacuum forming.

Nosco Plastics, Erie, Pa., custom injection molder, has expanded its facilities with the addition of a metallizing department. The company is now doing first-surface and second-surface metallizing in a specially pressurized metallizing room.

Anchor Plastics Co., Inc., Long Island City, N. Y., is expanding its manufacturing facilities to include additional extrusion capac-

ity, a 20% increase in fabricating machinery, and a development laboratory. The latter will be specifically designed to handle custom extrusion problems and materials development.

Sterling, Inc., manufacturer of Sterlco temperature control equipment for the plastics industry, has completed a new $200,000 plant and office building at 5200 W. Clinton Ave., Milwaukee 18, Wis. Provisions for future expansion have been made.

Meetings

Plastics groups

January 28-31: Society of Plastics Engineers, Inc., Fourteenth Annual Technical Conference, Sheraton-Cadillac Hotel, Detroit, Mich. Subject: "Progress through Plastics Engineering."

February 4-6: The Society of the Plastics Industry, Inc., Thirteenth Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Ill.

March 6-7: The Society of the Plastics Industry Canada, Inc., Sixteenth Annual S.P.I. Canadian Section Conference, Royal Connaught Hotel, Hamilton, Ont.

March 26-28: The Society of the Plastics Industry, Inc., Pacific Coast Section, Fifteenth Annual Conference, El Mirador Hotel, Palm Springs, Calif. Subject: "Progress in Plastics."

Other meetings

January 16-23: National Housewares Manufacturers Association, Twenty-eighth National Housewares Exhibit, Navy Pier and Drill Hall, Chicago, Ill.

February 6: The Chemical Market Research Association, Joint Meeting with Chemical Buyers Group, Sheraton-Park Hotel, Washington, D. C.

April 15-17: Society of Chemical Industry, Plastics and Polymer Group, Symposium on "The Physical Properties of Polymers." Additional information may be obtained from Mr. K. H. C. Bessant, The Distillers Co., Ltd., Great Burgh, Epsom, Surrey, England.

Companies . . . People

Union Carbide Corp.—Bakelite Co.: L. K. Merrill, appointed vice president—technical, will have staff responsibility for patents and licenses. Mr. Merrill joined National Carbon, a Div. of Union Carbide, Cleveland, Ohio, in 1920; in 1942, he was transferred to the Bound Brook, N. J., plant in charge of the Vinylite laboratories and two years later was made general superintendent of the plant. In 1952, Mr. Merrill was named vice president in charge of product and process development of Bakelite. **Dr. C. M. Blair** appointed vice president—planning and **R. D. Glenn** vice president—development. Dr. Blair joined the corporation's research laboratory in South Charleston, W. Va., in 1934. He was subsequently made superintendent of the chemical plant at Seadrift, Texas, and became product general manager—olefins for Bakelite in 1956. Mr. Glenn joined the organization in 1934 in the Production Dept. at South Charleston. He has most recently been product general manager—vinyls for Bakelite. **Arnold F. Sward** appointed manager—market research. He joined Union Carbide Chemicals in 1935 and has been successively manager of the Calendering, Molding, and Extrusion Materials Divs.; department sales manager of the Consumer Products Dept.; and general sales manager—bonding and laminating.

Upon accession to office, Dr. Blair made the following appointments: **J. L. Brannon,** product general manager—phenolics; **J. E. Brister,** product general manager—polyolefins; **L. E. Humphrey,** product general manager—polystyrene; and **W. R. Wheeler,** product general manager—vinyls.

Officials appointed at Bakelite's Bound Brook, N. J., plant are as follows: **J. A. Bruton,** general superintendent; **E. A. Haine,** services superintendent; and **W. A. Gay,** production superintendent.

Still further appointments made are those of **A. A. Boehm** as works manager for Bakelite; **R. F. Clash, Jr.** as director of development; and **W. J. Canavan** as manager—new products engineering.

Morse Dial, president of Union Carbide, also announces the appointment of **D. B. Benedict,** formerly president of Union Carbide Chemicals Div., as vice president of the corporation, responsible for its chemicals and plastics activities. **E. E. Fogle** named president of **Union Carbide Chemicals Div.** and **K. H. Rowland** vice president—production.

Union Carbide Olefins Co. is a new division of the corporation, with **H. D. Kinsey** as president. He joined Union Carbide in 1924 and has since served as assistant superintendent at South Charleston, superintendent at Whiting, manager of the Oak Ridge Manhattan project, and vice president of Union Carbide. **R. N. Graham** and **W. F. Reich, Jr.** named executive vice presidents; **N. C. Babcock,** vice president—marketing; **L. J. Bowditch,** vice president—engineering; **G. T. Felbeck,** vice president—research; and **E. P. Shetter,** vice president—production.

The newly formed company will handle the production and sale of the corporation's hydrocarbon products, including ethylene, propylene, and butadiene.

Editor's note: Keep your eye on this new division of Union Carbide. It is a highly significant move and the forerunner of future announcements of great moment to plastics and the coming age of polyolefins and stereospecific plastics. It could mean that Union Carbide is about ready to announce commercial production of low-pressure-processed polyethylene and perhaps polypropylene. Pilot plants have been in operation for more than a year and Union Carbide is not in the habit of making announcements of this nature until it is ready to proceed with a marketable product.

National Research Corp.: Frederick H. Greene, Jr., director of the Commercial Development Dept., elected vice president. He will continue as director of the department and general manager of **NRC Vaculite Corp. David D. Nickerson,** elected treasurer, following the retirement of **Kenneth G. Donald,** vice president-treasurer. Mr. Nickerson will oversee all financial operations of the company and its subsidiaries, which include **NRC Equipment Corp.,** high vacuum equipment manufacturer, and NRC Vaculite Corp., producer of vacuum metallized plastics.

Houghton Laboratories, Inc.: Joseph W. Tierney, manager of the **Plastic Tooling Div.,** elected a director. **Mark V. Goodyear,** technical director, appointed a director of **Hysol (Canada) Ltd.,** an affiliated company of Houghton located at Leaside, Ont. The Canadian firm manufactures a line of Hysol products for sales and service throughout Canada. Houghton is a compounder of epoxy resins.

Hooker Electrochemical Co.: Thomas E. Moffitt, with the company since 1930 and a director and vice president since 1956, elected president; he succeeds **Bjarne Klaussen,** retired after 41 years, but who continues as a director. **Ansley Wilcox II,** secretary and general counsel, elected vice president. **Dennis A. Riordan** plans to retire as treasurer and will be succeeded by **Thomas F. Willers,** who was also elected a vice president. **John F. Snyder** retired as vice president but will remain as director of the finance committee. **R. Lindley Murray** continues as board chairman and chief executive officer.

David S. Rosenberg named manager of process improvement and development, heading a new group formed to study and improve the firm's existing chemical processes as an arm of the Research and Development Dept. Initially, the group will comprise eight chemical engineers transferred from operations and process study. **Dr. Elliott P. Doane** replaces Mr. Rosenberg as supervisor, pilot plant, and will report to **Joy E. Beanblossom,** manager of development. **James E. Dillman** named technical supervisor, process study.

National Petro-Chemicals Corp.: Byron J. Anderson named manager of the polyethylene plant which will be built in Houston, Texas. He was a senior technologist for Imperial Oil Co., Ltd., of Canada, before joining National Petro-Chemicals at the Tuscola, Ill., plant, where he was recently assistant chief technologist. **Clifford Oman,** formerly process superintendent, now assistant plant manager of the Tuscola plant.

National Petro-Chemicals is a subsidiary of **U. S. Industrial Chemicals Co.** and **Panhandle Eastern Pipeline Co.**

The General Tire & Rubber Co.: John Donovan promoted to sales manager of sheeting and unsupported fabric at the **Respro Div.,** Cranston, R. I. **James Gillen** succeeds Mr. Donovan as sales manager of upholstery sheeting at the **Pennsylvania Plastics Div.**

Textileather Div: J. S. Mather, Jr., with the company 25 years and formerly general sales manager, appointed director of sales. He succeeds **Gerald H. McGreevy** who has retired after 33 years with the firm.

Bolta Products Div.: Frank Russo named sales service manager to replace **J. A. Wilcox,** appointed production control manager.

United States Rubber Co.—Footwear and General Products Div.: Joseph L. Pert, formerly sales manager of vinyl-coated fabrics, now sales manager of Ensolite and Ensolex, cellular plastic materials manufactured at the Mishawaka, Ind., plant. Ensolite, previously promoted by the firm through development sales, is used for shock absorbing and insulating application; Ensolex is a building insulating material. **C. Walter Carl-**

(To page 264)

Companies . . . People

son named container products field sales manager of the division, with headquarters in Providence, R. I. He will be in charge of the company's full line of portable rubber-fabric shipping and storage containers, marketed under the tradenames of Sealdbins, Sealdtanks, and Sealdrums.

Godfrey L. Cabot, Inc.: Dr. W. R. Smith, with the firm since 1936 and formerly associate director of research, named associate technical director in charge of international research liaison and consultant in fundamental carbon black research. **E. M. Dannenberg,** with the company since 1945, appointed director of carbon black research. **Raymond P. Rossman,** with the organization since 1937 and previously director of the research and development laboratories, now director of the newly formed Carbon Black Technical Dept.

Anchor Plastics Co.: Myron Rothman, plant manager for the past 13 years, appointed vice president in charge of production. **Leo Gans,** previously senior development engineer of Olin Mathieson Chemical Co.'s Film Div., named executive assistant; he will head the Chemical and Product Development Laboratory and supervise and coordinate customer relations and extrusion plant operations.

Du Pont—Polychemicals Dept.: Dr. Robert C. Doban, formerly research chemist, promoted to research supervisor to direct research on the development and application of Teflon 100X perfluorocarbon resin. **Alan F. Randolph,** a special assistant to the director of the Plastics Sales Div., retired after 41 years in the plastics industry. He is editor of the Plastics Engineering Handbook published by The Society of the Plastics Industry, Inc.

General Electric Co.—Plastics Dept., Decatur, Ill. **K. O. W. Sandberg,** formerly plant manager, now manager of manufacturing.

Silicone Products Dept., Waterford, N. Y.: **Harold W. LeBoeuf** appointed manager of intermediates operations, responsible for all phases of the manufacture of basic silicone intermediates. **Richard D. Rice,** named manager of rubber and polymer operations, will be in charge of the production of silicone gums and compounds.

Chemical and Metallurgical Div.— New Product Development Laboratory, Pittsfield, Mass.: **Keith Elston,** development chemist in G-E's Transformer Laboratories for the past nine years, transferred to the New Product Development lab to work on mica projects. **James C. Kelley** appointed development chemist and **James W. Robertson** chemist.

John E. Faloon, named supervisor of the newly reorganized Mycalex operations at Taunton, Mass., will direct all research, engineering, and production of G-E Mycalex molded parts. **Dr. George H. Bischoff** and **Edward W. Callahan** appointed development and product engineer, respectively.

American Cyanamid Co.—Formica Corp.: Dr. Stephen J. Groszos, formerly senior research chemist and project leader at the company's research laboratories in Stamford, Conn., now manager of resin development.

Branch sales office established at 2803-A 19th Pl., S., Birmingham, Ala., headed by **Ray A. Carson.**

New Jersey district office moved from Belleville to 18 N. Harrison St., E. Orange, N. J. The office serves Formica dealers and fabricators in northern New Jersey, Staten Island, N. Y., and northwestern Pennsylvania.

Westinghouse Electric Corp.: Herbert C. Smith, with the company since 1948, now sales manager of Westinghouse Electric Corp.'s **Micarta Div.,** Hampton, S. C. He succeeds **S. F. Davies** who has been named director of marketing, general products group.

Monsanto Chemical Co.—Plastics Div.: Henry F. Spadoni, Jr. now with Resinox Dept. at Springfield, Mass. **Thomas G. Lyons** named control laboratory supervisor at Texas City, Texas; **James R. Sheehan** joined the Maintenance Dept.; **Mrs. Lillian L. Wilson** joined the Production Coordination Dept. **Arthur C. Ryder** now with the engineering section, Production Dept., at Santa Clara, Calif.

Research and Engineering Div.: Dr. Lucius Gilman appointed manager of plastics and polymer research in the Special Projects Dept. at Everett, Mass. He was formerly consultant for the Materials Advisory Board of the National Academy of Sciences and chief of the Ordnance Corps Plastics Laboratory. **Donald W. Rice** joined the polymer section of the Research Dept. at Dayton, Ohio.

Organic Chemicals Div.: Robert O. Nellums now an assistant director of research at St. Louis, Mo.; **Dr. Richard S. Gordon** named group leader; **Dr. Wesley B. Argo** and **Oscar J. Marchand** promoted to department group leaders; **Dr. Constantine E. Anagnostopoulos,** research chemist, promoted to scientist; **Carl B. Sigler** appointed to newly created post of manager of materials handling services.

F. J. Stokes Corp.: Walter W. Goehring appointed manager of the Manufacturing Dept. He was formerly manager of manufacturing for the Can Div. of Crown Cork & Seal Co., Inc. and general factory manager of SKF Industries, Inc., a firm which he had served for 20 years. **Louis R. Garza,** previously export manager of Henry Disston Div., H. K. Porter Co., Inc., named manager of the International Div. The company manufactures vacuum processing equipment for the chemical, petroleum, pharmaceutical, and metalworking industries, as well as a line of plastics molding equipment and compacting presses.

In this section of the November issue, an item appeared to the effect that **Summit Industries, Inc.,** 2104 W. Rosecrans Ave., Gardena, Calif., had been formed to specialize in the manufacture of reinforced plastics

E. C. Mireau

A. S. Greenberg

products. Inadvertently, the names under the pictures of **Albert S. Greenberg,** president, and **E. Chris Mireau,** vice president, were transposed. The pictures are again reproduced herewith with the correct names.

Shell Chemical Corp.: D. S. Herr, formerly director of the Technical Service Laboratory in Union, N. J., exchanged positions with **F. S. Swackhamer,** formerly manager of the Sales Development Dept., Chemical Sales Div. The switch was made to give each manager a broader background of experience.

Emery Industries, Inc.: Orville W. B'Hymer, formerly assistant sales manager, promoted to the newly created post of customer service manager for the Fatty Acid Sales Dept. **Robert C. De Lollis** named sales representative for the Mid-Atlantic territory, succeeding **P. N. Leech,** transferred to the Chicago office.

St. Regis Paper Co.—Panelyte Div.: Paul Y. Chamberlin, formerly production control supervisor at St. Jean, Que., now plant manager of Michigan Panelyte Molded Plastics, Inc., Dexter, Mich. **Eli Hartz** continues as manufacturing manager of

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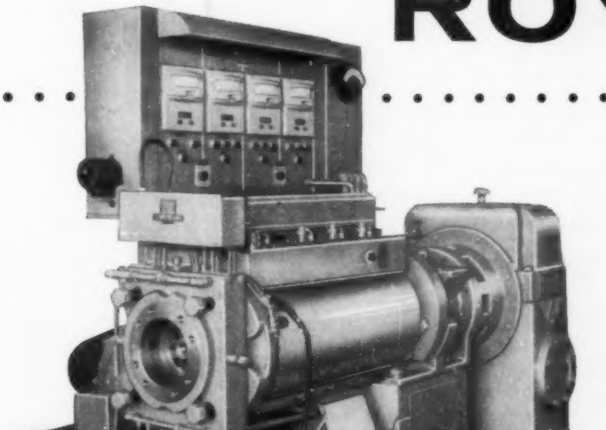

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Write for Bulletin #463

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Companies . . . People

the three thermoplastic molding plants at Dexter; Richmond, Ind.; and Cambridge, Ohio.

Chester Packaging Products Corp.: Robert W. Kohfeldt, previously material controls supervisor at Trenton, N. J., now plant manager of Chester.

The Richardson Co.: Dr. James R. Dudley, director of research and development, elected vice president; he will also continue his present duties. **Konrad Parker**, formerly with Cellotex Corp., now supervisor of application research.

General Aniline & Film Corp.—General Dyestuff Co.: Lewis R. Waddey, a sales executive at the Charlotte, N. C., branch for the past 25 years, appointed branch manager of the Chattanooga, Tenn., sales office. He succeeds **H. Alison Webb**, recently named assistant sales manager of General Dyestuff.

Davidson-Kennedy Associates Co.: A. T. Sieron appointed project manager and **Oliver J. Bolduc** chief process engineer. The company designs and constructs chemical process plants.

Dominion Plastics Co., 1913 Boulevard, Colonial Heights, Va., is the new name of the company formerly known as Lurie Plastics, Inc. The firm has discontinued the manufacture of sheet plastics and vacuum forming and will confine its activities to custom injection molding.

Jonathan Bryan is chairman of the board; **George B. Finney**, president and general manager; **James W. Coleman**, sales manager; **Raymond R. Ellis**, chief engineer; and **Kenneth Coates**, production superintendent.

American Chemical Society: Prof. Arthur V. Tobolsky of the Frick Chemical Laboratory, Princeton University, elected chairman of the society's **Division of Polymer Chemistry; Dr. Frank R. Mayo** of Standard Research Institute elected vice chairman of the division. Both appointees will serve for one year.

The Carpenter Steel Co., Reading, Pa., has opened a new and enlarged mill branch warehouse and office in Chicago, Ill., as midwestern headquarters of the main company and its Alloy Tube Div. The division will use these offices as a base of operations for a sales territory embracing 18 midwestern states.

The following sales executives will manage operations out of the new headquarters: **Paul W. Holtz**, district manager; **W. J. Stephens**, branch manager; and **John R. Seward**, warehouse manager. **Walter A. Baumstark** is midwest regional manager for the Alloy Tube Division.

The Borden Co.—Chemical Div. Clark Wakefield, formerly with National Lead Co., joined the Polyco-Monomer Dept. as Midwest district sales manager and will supervise eight sales territories from the Chicago office. **Maurice S. Letourneau**, technical sales representative for the Polyco-Monomer Dept., transferred from New England to Greenville, S. C. He will handle the company's line of polymers for the paint, paper, adhesive, and textile industries in the Carolinas and Virginia.

Air Reduction Chemical Co., Div. of Air Reduction Co.: Sales office opened at 3100 S. Homan Ave., Chicago, Ill., headed by **R. C. Gilardi**. He will be assisted by **J. G. Smith**. Products of the division include vinyl acetate, vinyl stearate, polyvinyl stearate, methyl butynol, methyl pentynol, Surfynols (surface active agents), etc.

Colton Chemical Co.: James K. Ames, previously Chicago district manager, now Central district sales manager. Colton products include Vinol polyvinyl alcohol, Vinac polyvinyl acetate emulsions and beads, Flexbond copolymer emulsions, Colfoam microballoon spheres, etc. used in the adhesives, coatings, paint, and textile industries.

Nopco Chemical Co.—Industrial Div.: William F. Dolan, Jr. named technical sales representative for North Carolina and the eastern part of Tennessee. He will handle processing chemicals, such as esters, ethylene oxide condensates, amides, resin and wax emulsions, etc.

Metasap Chemical Co.: Thomas J. Campbell appointed assistant to **O. E. Lohrke**, sales manager. Mr. Campbell will be primarily concerned with sales development of vinyl stabilizers.

Archer-Daniels-Midland Co.: Branch sales office opened at 300 Mt. Lebanon Blvd., Pittsburgh 34, Pa. **Charles A. Aldag**, formerly technical sales representative at Cincinnati, will manage the new office which will handle ADM's chemical products, vinyl plasticizers, etc. **Joseph A. Burns & Son**, 124 Harrison Ave., Pittsburgh, Pa., will continue as agent for ADM resins.

John C. Geiss, formerly manager of the St. Louis office, now manager of the Cleveland office, replacing **Gerald C. Berry** who was transferred to the Detroit office. **Louis H. Price** succeeds Mr. Geiss at St. Louis. He was formerly president of Price Varnish Co., Valley Park, Mo., until purchase of certain of that firm's assets by ADM.

Premmco, Inc., 5470 Valley Blvd., Los Angeles 32, Calif., has established a Northern California Div. at Alameda, Calif., to handle sales and service, with **H. Norman Eierman** as district manager. The company is a manufacturer's representative for Heli-Coil inserts and other products in the 11 western states.

Frederick S. Bacon Laboratories, Watertown, Mass.: **Richard S. Cass** and **William H. Crandell** were admitted to partnership in the organization. Bacon specializes in chemical research and product development.

Taylor Fibre Co.: Francis M. Guiney and **William J. Conlon** named sales engineers, assigned to the New York office at 76 S. Tyson Ave., Floral Park, L. I. **Jeremiah J. Sullivan, Jr.** made sales engineer and will cover the Philadelphia, Pa., territory. The company manufactures laminated plastics, rolled copper-clad laminates for printed circuits, and vulcanized fibre.

Farrel-Birmingham Co., Inc. has relocated its Akron, Ohio, office to 665 W. Market St.

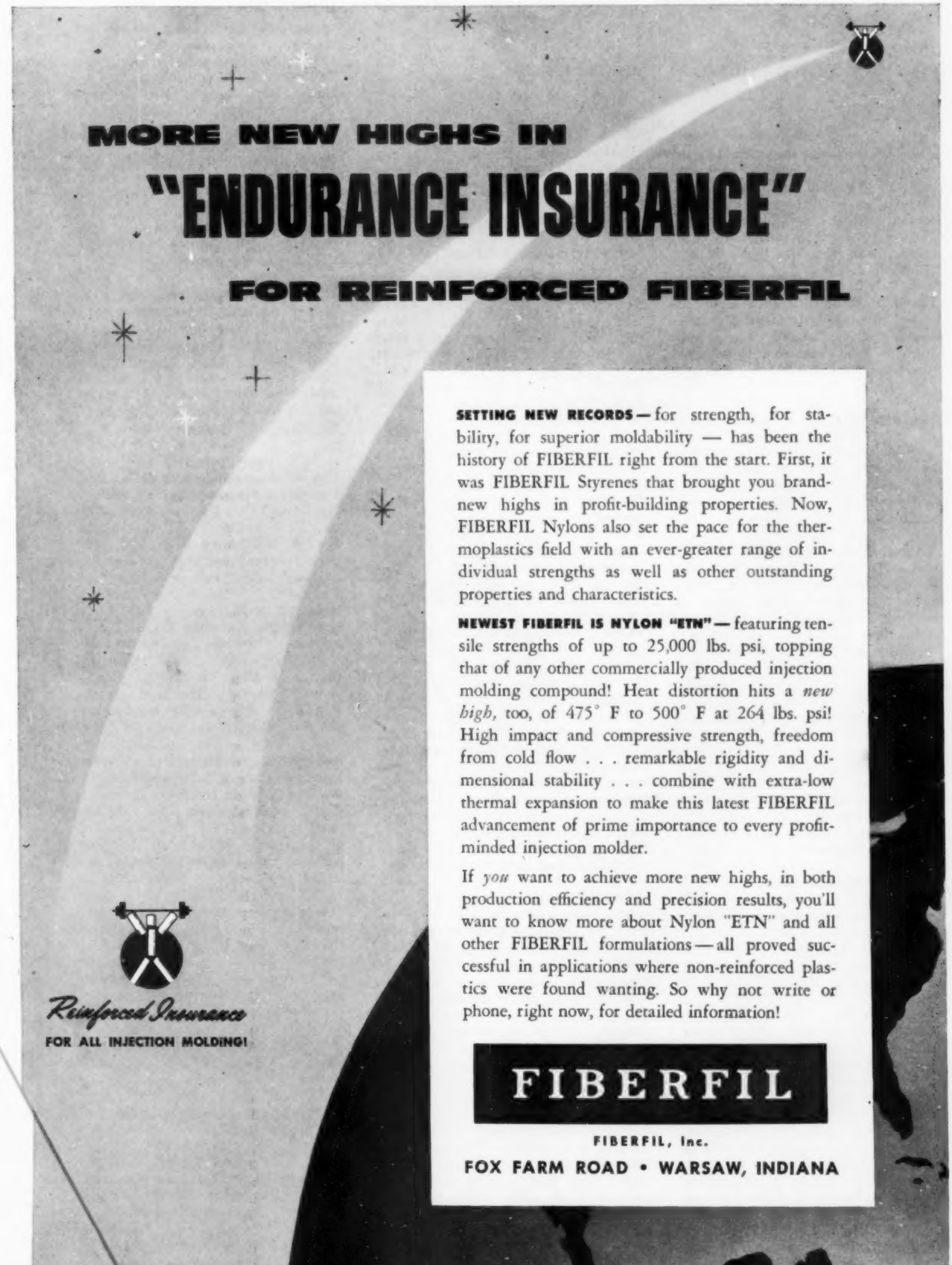
Pittsburgh Plate Glass Co.—Fiber Glass Div.: John H. Clark appointed manager of electrical product sales; he will also continue in his previous capacity as manager of wire and cable sales. **Edwin M. Penney**, formerly manager of quality control, textile sales, now manager of textile products sales.

Bensing Bros. & Deeney: Henry Myers named eastern sales manager, with headquarters in Philadelphia, Pa. He succeeds **Robert Bensing** who has moved up to executive vice president of the company. BBD produces flexographic printing inks.

Moreland Chemical Co., Inc., Spartanburg, S. C., appointed southern representative for Plaskon nylon molding compounds produced by **Barrett Div., Allied Chemical & Dye Corp.**

Enflo Corp. has moved to its new factory and office building located on Fellowship Rd., Maple Shade, N. J.

Sealomatic Electronics Corp., 429 Kent St., Brooklyn 11, N. Y., has opened a branch office at 2019 E. 7th St., Los Angeles 21, Calif., to handle sales and service of the firm's electronic heat-sealing equipment. The new office also represents Clifton injection molding and hydraulic presses, Thermomat vacuum forming equipment, and Radiant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Companies . . . People

heating panels. Other plastics fabricating equipment handled by the office include the Plasticor injection molder, Pacemaker thermal impulse sealers, blister packaging equipment, and Gruenberg ovens and sealers. **Harold Perlman,** formerly New York sales manager, heads the Los Angeles office.

Faeco Machine Co., Inc., manufacturer of plastics processing equipment and machinery, has moved from 229 Preakness Ave. to enlarged quarters at 643-21st Ave., Paterson 3, N. J.

Western Solvents & Chemicals Co., Detroit, Mich., named distributor for Igepal nonionic surfactants by **Antara Chemicals, Div. of General Aniline & Film Corp.** Igepal surfactants are used for detergency, wetting, emulsification, and dispersing.

Kimball-Tyler Sales Co., 261 S. Haven St., Baltimore 24, Md., appointed distributor for the Baltimore-Washington, D. C., area by **Barclay Mfg. Co., Inc.,** 385 Gerard Ave., New York 51, N. Y. The sales company will handle Barclay and Barcwood plasticoated wall paneling (coated with a melamine-silicone finish); Barclite translucent fibrous glass-reinforced paneling; and a line of accessories.

Blane Corp., Canton, Mass., manufacturer of vinyl compounds and vinyl color concentrates, appointed **Arnold & Co., Inc.,** 262 Washington St., Boston 8, Mass., as advertising and sales counsel.

Whitlow-Ringdahl, High Point, N. C., and Miami, Fla., manufacturers' representatives, appointed by **Kimball Mfg. Corp.,** San Rafael, Calif., to handle its line of fibrous glass planters and decorative accessories in Florida, Georgia, and the Carolinas.

H. A. Roes & Co., 2601 Cherry, Kansas City 8, Mo., appointed midwest technical sales representative by **Tri-Point Plastics, Inc.,** Albertson, N. Y. Tri-Point products and services to be handled by Roes include TSI Teflon rod, precision-machined Teflon, and other plastics parts for the electronics industry; subminiature Teflon stand-off and feed-through terminals; and others.

Dr. William P. Utermohlen, Jr. appointed director of research of **Velsicol Chemical Corp.,** Chicago, Ill., responsible for all fundamental and applied research in chemicals, polymers, resins applications, organic processes, agricultural, and other fields of new interest. The division which he heads will work closely with the New Products and Process Development Div. of the Research and Development Dept.

Dr. Emery Parker, formerly director of research and technical development of Advance Solvents & Chemical Div., Carlisle Chemical Works, Inc., appointed to the newly created post of director of chemical market development of **Wallace & Tiernan, Inc.,** Belleville, N. J. He will be responsible for developing markets for new products and extending the markets and uses of basic chemicals and chemical intermediates now produced by the firm. The products now made by the company's two chemical divisions include sebacic acid, plasticizers, fatty acids, and organic peroxides.

James S. Lunn, president of **Lunn Laminates, Inc.,** Huntington Station, N. Y., re-elected chairman of the Executive Committee of the **Reinforced Plastics Div., The Society of the Plastics Industry, Inc.,** for 1957-1958.

T. Walter Noble, technical director of **Decar Plastic Corp.,** appointed chairman of the Decorative Laminate Advisory Technical Committee of the **National Electrical Manufacturers Association.** The function of the committee covers the entire group of decorative laminates, including physical properties, test methods, test equipment, and minimum standards of performance in accordance with the test methods established.

Howard D. Hartough appointed general manager of the Girdler Catalyst Dept. of **National Cylinder Gas Co.** He will be in charge of all phases of research, development, production, and application of catalysts manufactured in the Louisville, Ky., plant. The catalysts are used in gas processing and synthesis, gas removal, hydrogenation, and similar processes used in the plastics, petroleum, chemical, and other industries.

Clifford C. VanderWall, formerly director of manufacturing, elected vice president in charge of manufacturing of **Ansul Chemical Co.,** Marinette, Wis. His former title was abolished; he will continue to direct all the chemical and mechanical operations of the company.

Harold J. Schneider, appointed to the industrial sales staff of **United Shoe Machinery Corp.,** Boston, Mass., will handle the firm's new Thermogrip hot-melt adhesive system and Boxmaster carton-forming equipment. Operating out of the New York City office, Mr. Schneider will cover Southern New England, New York State, New Jersey, Pennsylvania, Maryland, Delaware, and parts of Virginia.

Dennis J. Hardwicke appointed general manager of **Metal & Plastic Compacts, Ltd. (Plastic Division),** Small Heath, Birmingham, England, to succeed the late **Jan Roll.** The company manufactures motor cycle and scooter accessories.

Jay D. Sherman, formerly New York district manager, now eastern sales manager of **Reed-Prentice Corp.,** a subsidiary of **Package Machinery Co.,** Worcester, Mass. He will supervise sales of the firm's plastics injection molding machines and die-casting machines in R-P's New York, Buffalo, and Worcester offices.

Allin C. Bears, formerly sales manager of **Joanna Western Mills, Inc.,** named sales manager of the **Velvetex Div., Velvery Corp.,** 15 W. 34th St., New York, N. Y., to succeed **John E. Williams,** retired. The company is a manufacturer and supplier of vinyl fabric wall coverings.

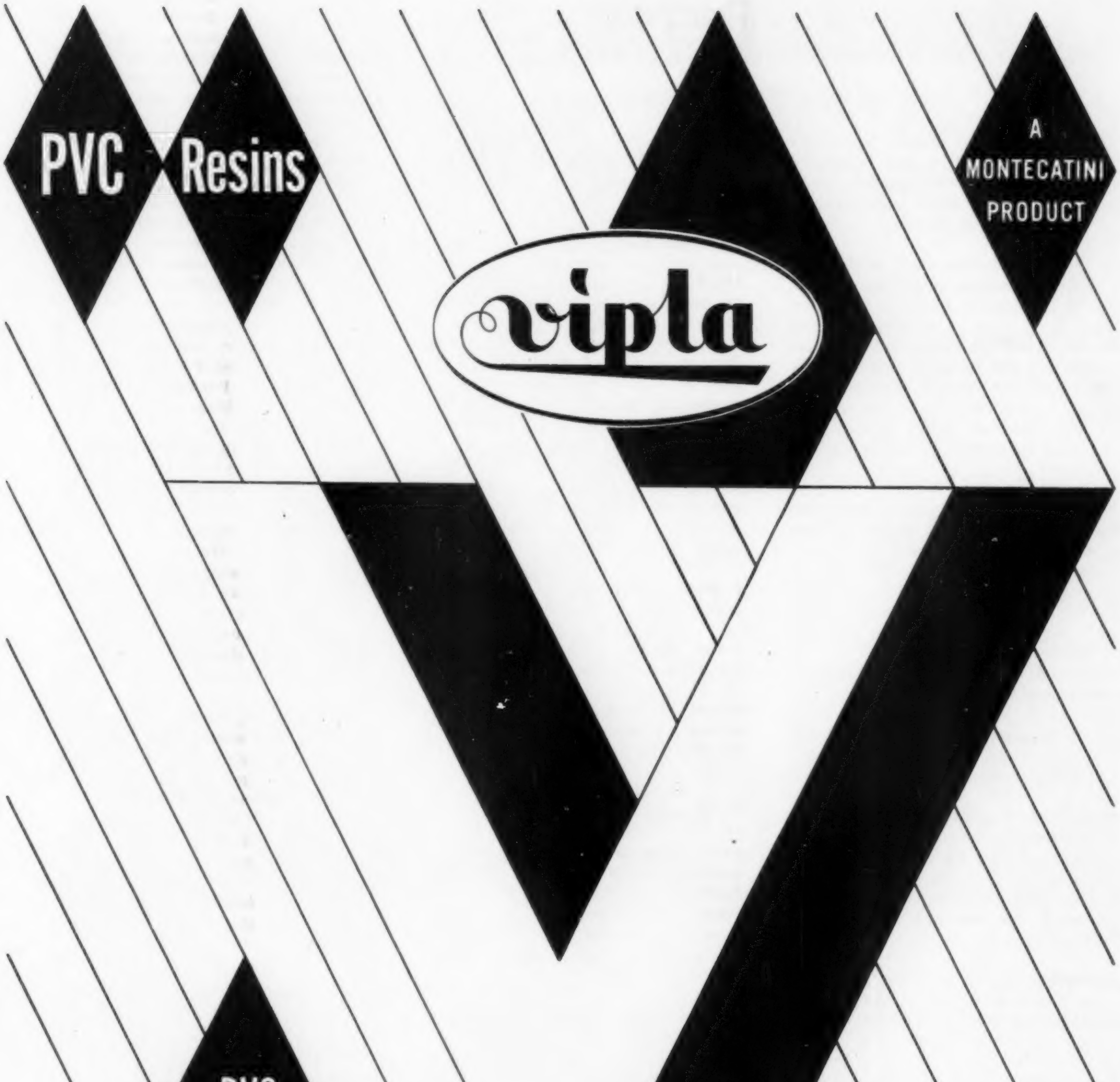
Robert J. Reid, formerly field engineer of **The Rainville Co.** of Pennsylvania, Abington, Pa., now Chicago district manager of **The Rainville Co.,** with offices at 3105 N. Cicero Ave., Chicago, Ill. The firm specializes in the sale of equipment to the plastics industry.

Robert K. Roulston named sales manager of the **Injection Molding Machine Div. of Lombard Governor Corp.,** Ashland, Mass. The appointment will spearhead the expansion of the firm's organization to effect national distribution through selected representative companies.

Dan Westreich appointed sales representative of the **Thermoplastic Div. of Catalin Corp. of America** in the New York-New Jersey area. He will handle sales of polystyrene, polyethylene, and nylon molding and extrusion compounds.

Arthur B. Robinson, formerly sales manager of the firm's Bo-Kay line of molded fibrous glass flower boxes, jardinieres, and birdbaths, promoted to vice president-sales of **Plastic Products Corp.,** Cleveland, Ohio. His new duties will include management of all proprietary lines, including the Town & Country fibrous glass mailbox and the Red Socket fibrous glass toboggan.

Robert S. Schmidt now district sales manager of **Tracerlab, Inc.,** covering nine western states, Alaska, and Hawaii. Mr. Schmidt, with headquarters at 2030 Wright Ave., Rich-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Companies . . . People

mond, Calif., will handle the firm's complete instrument and industrial lines, as well as the reactor monitoring instrumentation and services at the Richmond division.

A. M. "Mel" Lipscomb, previously assistant manager of quality control for the Western Div. of Firestone Tire & Rubber Co., now on the Pacific Coast sales staff of **The Baker Castor Oil Co.** Based at the Los Angeles office, Mr. Lipscomb will handle sales and technical service to the plastics, resin, paint, and chemical industries in the Southern California area.

G. C. Zwick appointed special field representative of **The Goodyear Tire & Rubber Co.'s Chemical Div.**, with headquarters in Chicago, Ill. He will provide sales and technical service for the high polymer resins, rubbers, and latices marketed by the division.

Warren E. Benedict, named assistant marketing manager for market services, will handle advertising and sales promotion for **Miraplas Tile Co.**, Columbus, Ohio. The firm manufactures plastic wall tile.

Ernest J. Csaszar, formerly with Eagle Tool & Machine Co., now sales engineer of **Newark Die Co.**, 20 Scott St., Newark, N. J. The company specializes in the design and production of molds for the plastics and die-cast industries.

Ben J. Trombetta, with the firm since 1949, appointed assistant to the sales manager of **Acheson Dispersed Pigments Co.**, Philadelphia, Pa.

Bernie Chip appointed sales manager of **Krieger Color & Chemical Co., Inc.**, 6531 Santa Monica Blvd., Hollywood 38, Calif., manufacturer of Poly Supra colorants for injection and extrusion molding.

William H. Davis, previously director of sales development, now manager —chemical sales, of **Petro-Tex Chemical Corp.**, Houston, Texas. The firm is jointly owned by **Tennessee Gas Transmission Co.** and **Food Machinery & Chemical Corp.**

Jack H. Dollinger, sales manager of **Ferro Chemical Corp.**, subsidiary of **Ferro Corp.**, promoted to general manager. He will have the responsibilities of both positions.

James W. Hull, general manager since 1955, elected vice president of **Reynolds Chemical Products Div., Stubnutz-Green Corp.**, Ann Arbor, Mich. The company manufactures plastisols and organosols, as well as vinyl foams for seating, clothing, furniture, automotive, and industrial applications.

Ralph W. Giffin, formerly assistant sales manager, promoted to general sales manager of **Alsynite Co. of America**, San Diego, Calif. He succeeds **W. D. O'Morrow** who has resigned. The company manufactures translucent fibrous glass panels.

Gordon W. Menges appointed to the Sales Dept. of **Raffi & Swanson, Inc.**, Wilmington, Del., producer of industrial finishes. He will be in charge of new development, a post recently created to evaluate and introduce new products developed by the Research Dept.

R. Wesley Fish, formerly sales and service engineer in the **Machinery Div.**, appointed to a similar position in the **Roll Div.** of **United Engineering & Foundry Co.**, Pittsburgh, Pa.

Chester F. Rental has rejoined **The Stanley Chemical Co.**, a subsidiary of **The Stanley Works**, E. Berlin, Conn., as technical service supervisor. He will be responsible for customer field service.

J. H. Tigelaar named manager of research and development of **Cadillac Products, Inc.**, Warren, Pa. The firm manufactures polyethylene bags, liners, and specialties; cushioning materials; and industrial paper products.

Robert W. Woollen, formerly manager of **W. R. Grace & Co.'s** New Orleans export-import office, elected assistant treasurer of **Petroleum Chemicals, Inc.**, New Orleans, La.

Emory D. Seles has joined **Columbian Carbon Co.**, 380 Madison Ave., New York 17, N. Y., as a technical service engineer. He will be concerned with the application of pigments in plastics, paints, and inks.

Corrections

"Reinforced plastics conference," p. 180, December 1957: The following changes in program are noted:

February 4: SESSION I—MATERIALS SURVEY: Title of paper given by D. F. Doehnert and Dr. O. L. Mageli changed to *"Evaluation of Organic Peroxides on the Basis of Half-Life Data."* SESSION II—STRENGTH-TIME BEHAVIOR (MATERIALS AND LAMINATES): A. Houze additional author of paper *"Improvement of Reinforced Plastics by Fibers from New Glasses."* R. E. McVickers, Bureau of Aeronautics, additional author of paper *"Tensile Strength of Glass Fibers."* SESSION III (P.M.)—INDUSTRIAL DESIGN: Additional paper *"Reinforced Plastics in Architectural Applications,"* A. Forte, Holabird & Root & Burgee, Architects. SESSION I (P.M.)—STRENGTH TIME BEHAVIOR (SPEED, TEMPERATURE, RADIATION); Author of *"Subsonic and Supersonic Rain Erosion"* is G. P. Peterson.

February 5: SESSION II—PROCESSING: Title of paper by K. A. Schneider changed to *"Vacuum Pressure Injection Molding of a Reinforced Plastic Helicopter."* Paper of D. F. Anderson now titled *"Fiberglass and Resin as a Manufacturing Technique;"* affiliation changed to Rand Development Corp. SESSION III —BOAT CONSTRUCTION: Paper of E. F. Culwick and D. Savitsky changed to *"Design and Development of an Outboard Runabout Boat."*

February 6: SESSION II—FILAMENT WINDING: Authors of *"Development of Improved Filament-Wound Pressure Vessels" are George Epstein and Harry A. King.*

"Hydrostatic pressure effect on polymer melt viscosity," by *Bryce Maxwell* and *Alex Jung*, p. 174, November 1957: The sentence in the fourth paragraph reading "What is not immediately apparent, however, is that these investigations by and large consider only the effects of hydrostatic pressure on viscosity," should read, ". . . consider only the effects of temperature on viscosity."

Companies and People, p. 304, November 1957: J. Earl Fraser Co.'s appointment as exclusive representative for Kaye-Tex Mfg. Corp. refers *only* to the sale of Kaye-Tex vinyls as original equipment in the automotive field.

"World trade in plastics," by *Erich Gansmuller* and *Robert W. Crawford*, p. 109, October 1957: To be added to list of vinyl resin manufacturers in Germany, Chemische Werke Hüls A. G., Marl b. Recklinghausen. The company states that it is the chief manufacturer of vinyl resins in that country.

Modern Plastics Encyclopedia issue, 1957: Electro-Technical Products Div. of Sun Chemical Corp., Nutley, N. J., should have been listed in the Directory Section as manufacturers of Vinyl-coated fabric; Vinyl chloride film and sheeting; Epoxy, Melamine, Oil Base, Phenolic, Silicone and Urea Coatings; Resin Loaded Glass; Low Pressure Laminating Resins; Organosols and Plastisols, and Resin Impregnated and Coated Paper. The company also does dip-coating and impregnating and coating of fibrous glass. These listings should have indicated that it is an advertiser in this issue. The advertisement, which concerns "Sunform" reinforced plastics for low-pressure laminating appears on p. 501.

Classified Advertisements

EMPLOYMENT • BUSINESS OPPORTUNITIES • USED OR RESALE EQUIPMENT

Machinery and equipment for sale

FOR SALE: All in stock—1—Royle #2 extruder, elec. heating. 1—Cumberland #1½ cutter. 3—4' x 7' Vulcanizers, ASME 125# WP, 650° F, Quick-opening doors. 3400 HP Farrel-Birmingham horizontal reducer. Double arm sigma blade mixers —2¼, 5, 10, 20, 30, 60, 75, 100, 150 gal., stainless steel and steel. Rotary & single punch Tablet or Preform Presses—Stokes "R", "T", "DD-2", "RD-4", Kux rotary 21, 25 punch. Perry Equipment Corp., 1429 N. 6th St., Phila. 22, Pa.

FOR SALE: 3 self-contained compression molding presses, 350, 200 and 50 tons capacity; 1 MPM 2½" electrically heated extruder; 3 Cumberland #½ plastic granulators, 3 HP; 1 Mitts & Merrill model 10-N-9 pelletizer; 1 Stokes T preform press; also mixers, mills, grinders, etc. Chemical & Process Machinery Corp., 52 Ninth St., Brooklyn 15, N.Y.

FOR SALE: One 16-oz. Watson-Stillman Machine taken in trade on larger machine, and completely overhauled. In good operating condition. Reply Stanley Berg Machinery Co., 1231 Banksville Road, Pittsburgh 16, Pa.

GOOD EQUIPMENT: At the right price. Falcon Ribbon Blenders in Steel or Stainless; NRM 2½" Extruder, Royale #3 Extruder; Rotary Cutters by Ball & Jewell, Sprout-Waldron, Abbe; Baker Perkins heavy duty dbl. arm Mixers, 100, 200, 300 gal; French Oil Mill Hydr. Press 450 Ton; Blaw Knox S/S Resin Kettle 7'6"x7'6", Jktd. Agtd.; Sturtevant 300 cu. ft. Batch Mixer; Stokes and Colton Rotary and Single Pre-form Presses; Send for new First Facts, containing complete illustrated inventory; First Machinery Corp., 209 Tenth St., Bklyn 15, N.Y. Fred R. Firstenberg, Pres.

FOR SALE: Stokes DDS-2 Rotary Tablet Press 1" Diameter punches and dies, Stokes Model R Tablet Press 1" Diameter punch and die, 4-Hydraulic compression molding presses. Pull back cylinders, knockouts, individual power units. 1—75 Ton, 3—125 ton. Triboro Electric Corp., 110 Waterbury St., Bklyn 6, N. Y., HY-7-3535.

FOR SALE: Banbury mixers #3 & 3A, 2 roll mill 18 x 36, 2 roll Thropp Calender 12 x 16, French Molding Press 200 ton 24 x 36" bed, Powermaster Boiler 15 HP 100 psi. Unimax Corp., 8200 Bessemer Ave., Cleveland 27, Ohio.

SEPORE: 150 ton hydraulic hot plate press 24" x 24" 2 daylight openings, electrically heated platens, thermostatically controlled to 450° F., rated to 3000 PSI line pressure, never used, $2500.00. Complete specifications available on request. Simplex Mfg. Company, Inc., Auburn, New York.

FOR SALE: Lester L-21/8-8 ounce Injection Molding Press, 1946. Complete with motor, controls and Wheelco instruments. Machine in good condition. Price $5,900. (4) Peerless Pedestal Type, hot roll leaf stamping presses. Price $400. each. Reply Box 3117, Modern Plastics.

STAINLESS STEEL KETTLE: Capacity available for volume Esterification, Sulfonation, Plasticizer, Resin Production. Reply Box 3112, Modern Plastics.

LIQUIDATION SALE — MOLDING PLANT: (1)—300 Ton Erie Compression press; (2)—250 Ton French Oil Compression; (2)—170 Ton Transfer Press; (3)—75 Ton Transfer Press; (1)—No. 5½ T Colton Preform Machine; (1)—3 DT Colton Tablet Machine. Also Air Compressors, Pre-Heaters and miscellaneous shop equipment. Reply Box 3125, Modern Plastics.

FOR SALE: 1 4½" Prodex Extruder with Dynamatic Drive; 1 6" Hartig Extruder; 1 Hopper; 3 Pipe Pullers; 3 Hopper Dryers; 3 Water Cooling Tanks, ½" thru 2" Pipe Dies; 1 Cumberland Granulators. Equipment may be seen at Orangeburg Manufacturing Company, Orangeburg, New York.

FOR SALE: Formvac #2 G5 Vacuum forming machine—Double platten 40" x 60", used approximately 2 months; 300 gallion auxiliary vacuum tank included. Purchased new 1955. Reasonable offer considered. John Mack & Son, 6227 N. Broadway, Chicago, 40, Ill. Telephone: Ambassador 2-2525.

FOR SALE: Injection Presses: Jackson-Church 64 oz., HPM 60, 48, 20, 16, 9, 6 & 4 oz. Reeds: 22, 16, 12 & 8 oz. Lester 8 & 12 oz. Watson 28, 12 & 6 oz. Lewis 4 oz. Moslo 2½ oz. Van Dorn 1 oz. Extruders: 3½" oil heated. NRM w. crosshead.—30" Sheet Die w. 52" Pull-Off. Dulmage Meterpump 28".—Despatch PLHD 6 & 10 draw. Ovens.—Eclipse 6 HP boiler, 2 HP boilers. Apex 2 col. Container Imprint mach.—Compression Presses 50 to 200 tons. Elmes Hydrolair press 30 T.—Preformpresses: Colton 5½ T, Stokes 280 G.—Baker—Perkins 200 gal. mixer. 42 cft Ribbon Mixer. Vac. Forming mach. 30 x 30", 40 x 60" Dake 200 T. Press.—List your surplus equipment with me. WANTED: Stokes Standards 50 to 150 T. Extruders 1½ to 4½". Defiance No. 20 Preformpress.—All midwest locations! Justin Zenner, 823 Waveland Ave., Chicago 13, Ill.

FOR SALE: (6) 100 ton, 10" ram, 10" stroke @ $1250; (7) 200 ton. 9" stroke, 14" ram, 36x36, @ $2160; (6) 200 ton, 9" stroke, 15" ram, 30x30 @ $1850; (1) ton complete, 18x18 @ $1850; (1) 200 ton 16" ram, 30x30 @ $2450; (2) 200 ton 16" ram, 42x42 @ $2850; (1) 200 ton, 15" ram, 42x42 @ $2600; (3) 250 ton (2) 12" ram, 30x60 rebuilt @ $3675. Hydraulic Sal-Press Co., Inc., 386-90 Warren Street, Bklyn, N.Y.

AVAILABLE AT BARGAIN PRICES: 2—Pneumatic Scale Co. Cartoning Units, consisting of Automatic Carton Feeders, Bottom Sealers and Top Sealers. 50 per minute. 4—Scandia Practically New Automatic Cellophane Wrapping Machines. 1—Hayssen Model 10-20 Wrapping Machine, with electric eye. 4—Fitzpatrick Stainless Steel Comminuters with 7½ HP motors and with Vibrator Feeders. 1—Mikro Pulverizer with 40 HP motor and complete auxiliary equipment. 1—J. H. Day mixer with ribbon & wire Agitators and 5 HP motors, 500# cap. 2—J. H. Day Mixers with ribbon and wire Agitators and 20 HP motors measuring 96"x36"x40". Complete details and quotations promptly submitted. Union Standard Equipment Co., 318-322 Lafayette St., New York 12, N. Y.

FOR SALE: 2 oz. Van Dorn, lever type, $1650; (3) 2 oz. aut. molding machines w/accumulator; 4 oz. Lewis, 1954, $3500; 4 oz. Acme, 1953, $5000; 4/6 oz. R-P, 1955; 4 oz. vert. DeMattia; 8 oz. R-P, 1948, $6500; 8 oz. R-P, 1946, $6000; 12 oz. W-S, Model E, $6500; 12 oz. DeMattia, toggle, $5000; 12/16 oz. DeMattia, Model M, $16,500; 12 oz. Lester w/solid frame, $5500; 16 oz. & 20 oz. vert. Impcos; 20 oz. R-P w/32 oz. cyl., almost new; 32 oz. R-P w/48 oz. cyl. exceptional; 48 oz. W-S, 1950; Model #246 Vactrim vacuum former; Preplasticizer for 16 oz. H.P.M., 48 oz. cap., almost new, for Model 350 B; tumbling barrels, ovens, grinders, etc. Partial listing—other equipment available. Acme Machinery & Mfg. Co., Inc., 2315 Broadway, New York City, Su 7-1705.

FOR SALE: Presses—1000 ton vertical—300-400 ton 36"x36" platens—500 ton R.D. Wood Downworking—4 oz. Injection Machine—No. 1 Ball-Jewell Grinder—Laboratory Presses to 75 ton—6"x13" Laboratory Mills—¾" Solenoid and Cam Operated Valves—Heating Kettles. Plastic Machinery Exchange, 426 Essex Ave., Boonton, N.J., telephone DE 4-1615, cable address Plasmex-Boonton.

FOR SALE: Never used 30 H.P. Explosion Proof tilting high shear mixer. Speed can be adjusted from 900 to 7200 R.P.M. 60 cycle 220-440 with extra blades & equipment ideal for plastisols, plastigels or very viscous solutions. Also used 3 Rolls 16x40 paint mill, water cooled. Will sell or trade for rubber mill in working order. Samuel Smidt Chemical Co., 410 Frelinghuysen Ave., Newark, N.J.

FOR SALE: 64 Oz. Injection Molder with Pre-Plasticizer mold size 32"x50" 750 Ton clamp. Lester 8 oz. Model 2 ½L (1949). De Mattia 12 oz. (1946). De Mattia 4 oz. H.P.M. Rubber Injection molders, 21½" x28" mold space, steam heated platens. Watson Stillman 300 Ton Semi-Automatic Compression molding Press (1947) self-contained, mold size 34"x27". Watson Stillman 250 Ton 28"x24". Watson Stillman 140 Ton 22"x16". Waterbury Farrel 85 Ton 20"x24". W.F. 63 Ton 15"x15". Laboratory Presses—Elmes 20 Ton 8"x8", others 15 Ton 10"x8" and 10 Ton 6"x6" Platens. Scrap Cutters, Valves, Accumulators, Hydraulic Presses—all sizes. Aaron Machinery Co. Inc., 45 Crosby St., New York, N.Y. Tel.: WAlker 5-8300.

FOR SALE: Stokes 300 ton and Baldwin-Southwark 200 ton semi-automatic Transfer Molding Presses. Thermal (La Rose) Preheaters. 2500 ton downstroke 54"x102". 800 ton Laminating Press 26"x38". 600 ton Baldwin 32"x36". 300 ton multi-opening 40"x40". Elmes 200 ton 28"x26". Farrel 200 ton 20"x80". 200 ton Hobbing Press. D&B 140 ton 36"x36". French Oil 120 ton self-contained. Also Lab Presses to 100 tons. Hydraulic Pumps and Accumulators. Van Dorn 1 and 2 ounce Injection Machines. Other sizes to 80 oz. Baker-Perkins and Day jacketed Mixers. Plastic Cutters. Oxford 57" Slitter. Seco 6" x 13" and 8" x 16" Mills and Calenders. Oil and Elect. Plastic Extruders, lab to 6". Single & Rotary Preform Presses ½" to 4". Partial listing. We buy your surplus machinery. Stein Equipment Co., 107—8th Street, Brooklyn, New York.

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FOR SALE: 1-Baker Perkins size 15USE, 100 gal. all stainless double arm Vacuum Mixer; 1-Baker Perkins size 15VUUM, 100 gal. double arm Mixer, 100 HP motor; 6-Day 250 and 100 gal. double arm Mixers; 1-Ball & Jewell #1 Rotary Cutter; 2-Two Roll Mills 6"x12"; 6-Stokes Model DD2, DS3, D3 and B2 Rotary Preform Presses; 4-Stokes Model "R" single punch Preform presses; 1-Kux Model 15-25 Rotary Preform Press; Also: Sifters, Banbury Mixers, Powder Mixers, etc., partial listing; write for details; we purchase your surplus equipment; Brill Equipment Co., 2407 Third Ave., New York 51, N.Y.

Machinery wanted

Stokes 235 or 235A Automatic Molding Press. It must be in operating condition. Request inspection before purchase. This equipment will be purchased anywhere in the U.S. or Canada. Reply Bud Gagliasso, Sawyer's Inc., P. O. Box 490, Portland, Oregon.

WANTED: Injection molding machines. We are particularly interested in larger equipment. Please give size, platten, cylinder, and asking price in your letter. Tee-Vee Toys, Inc., 124 Water St., Leominster, Mass.

WANTED: Used Blendor, Motor and Drive approx. 270 cub. ft. 36" Refiner, Motor and Drive, Granulator Ball & Jewel #2 Late Model, Pulverizer and Bale Pie Cutter. Reply Box 3113, Modern Plastics.

Materials for sale

MATERIALS FOR SALE: 100,000 lbs black general purpose medium flow phenolic molding compound. 40,000 lbs black flock-filled medium impact phenolic molding compound. 20,000 lbs glass filled phenolic molding compound. 50,000 lbs pulverized phenolic woodwaste resin. Chicago Area, make offer to Reply Box 3105, Modern Plastics.

Materials wanted

WANTED:
Plastics Scrap and Rejects of all kinds. Ground and unground. Also rejected molded pieces and surplus virgin molding powders. Top prices paid. Reply Box 3111, Modern Plastics.

WANTED:
Vinyl, polyethylene and styrene scrap for our manfacture of molding and extrusion compounds. We can use rigid from vacuum forming, lumps, bleeder, slabs, trimmings, rejects—anything suitable for reprocessing. Send samples and details or telephone. Steady buyers since 1940. Rotex Rubber Company, Inc., 1-23 Jabez Street, Newark 5, N.J. MArket 4-4444.

SCRAP WANTED: Highest prices being paid for sheet scrap or surplus pellets. Only interested in Royalite, Cycolac, or Krolastic. Will accept mixed colors at no price penalty. Reply Box 3121, Modern Plastics.

Molds for sale

HOUSEWARE MOLDS: 44 Plastic houseware molds for injection molding. Attractively priced for quick disposal. Terms available. Reply Box 3118, Modern Plastics.

FOR SALE: Houseware molds, comb molds, also some novelty and specialty items. All in excellent condition. No reasonable offer refused. Send for list. Reply Box 3114, Modern Plastics.

Molds wanted

WANTED: Tissue Box Mold by Mfgr. to fill in line. Will purchase or lease same. Contact Clipper Products Company, Box 0, Malvern, Penna.

TOY MOLDS: for injection molding. Submit samples and information. Reply Box 3115, Modern Plastics.

Help wanted

RESIN SALESMEN: Manufacturer of polyvinyl chloride resins seeks aggressive, experienced representatives with established contacts—preferably men who also handle plasticizers. Liberal compensation; excellent growth potential. Exclusive territories available throughout U.S. Interviews directly with top management. Send resume and full details in strictest confidence to Box 3128, Modern Plastics.

CALENDAR PRODUCTION MANAGER: Thoroughly experienced for vinyl film and sheeting. Excellent opportunity. Reply Box 3127, Modern Plastics.

INJECTION MOLD ENGINEERS: Attractive opening in molding plant for qualified engineers, experienced in the design and development of molds and fixtures for high volume production of acrylics, nylons, and cellulosics. . . . Applicant should be a graduate engineer or equivalent with several years of experience in this field. Excellent opportunity for advancement. Send resume to: Ford Motor Company, Salaried Personnel, P. O. Box 412, Ypsilanti, Michigan.

CHEMIST: Must be familiar with the production of polyethylene Resin and foam Vinyl compounds. This is an exceptionally good opportunity for the right man. Reply Box 3109, Modern Plastics.

PERSONNEL: Executive—Technical—Sales—Production. Employers and Applicants—whatever your requirements, choose the Leader in Personnel Placement. Cadillac Associates, Inc., Clem Easly—Consultant to Plastics Industry, 220 South State, Chicago 4, Ill.—WAbash 2-4800. Call, write or wire—in confidence.

CHIEF ENGINEER: Injection Molding—Must be thoroughly experienced and capable of supervising and assuming full responsibility for all phases of Engineering. This is an excellent opportunity, both from the standpoint of compensation as well as future advancement, for the man who can qualify. Reply in complete detail to Wolverine Plastics, Inc., Milan, Michigan.

PLASTICS ENGINEER: thoroughly experienced in job quotation, mold and product design, knowledge of nylon injection molding process and applications Customer contact necessary on technical problems. Permanent position with attractive future. Excellent salary. Relocation expenses paid. Northeastern Ohio area. Send complete resume. Replies held in strictest confidence. Reply Box 3120, Modern Plastics.

COLLEGE GRADUATE: with 2-5 years experience in color matching and color compounding in plastic materials. Must be willing to relocate. Position offers unlimited opportunities with growing plastic division of large chemical company. Reply Box 3101, Modern Plastics.

SUPERVISOR: Decorating Department—Experienced in supervision of production operations on both vacuum metallizing and spray painting. An excellent opportunity. Reply in detail to: Wolverine Plastics, Inc., Milan, Michigan.

CONSULTANT: for Eastern Extrusion Plant setting up a new Garden Hose Program. We would also like to hear from people interested in handling sales of this product. Reply Box 3108, Modern Plastics.

MANUFACTURERS' REPRESENTATIVE WANTED: Custom Molder (Compression & Transfer) in New England wants New York State representation. Straight commission, protected territory. Reply Box 3107, Modern Plastics.

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TECHNICAL SALES: EPOXIES Challenging career opportunities available with expanding, prime-producer and developer of epoxy resins. Four openings exist (California, New England, Philadelphia and Florida areas) for Technical Sales Representatives, desirous of growing with the exciting and versatile epoxies. Prefer Chemical Engineer with sales experience and resin background, age 25-35. Please submit detailed resume of education, experience, salary requirements, etc. in complete confidence to: Mr. Fred J. Coles, Personnel Dept., Ciba Company Inc., Kimberton, Penna.

GENERAL FOREMAN: Finishing Department. Established Chicago area injection molder has immediate opening for top man in finishing department. Must be good organizer and capable of handling people. Unusual opportunity for growth with company that is expanding. Stock option and bonus plan. Reply in confidence giving experience and salary history. Reply Box 3103, Modern Plastics.

WANTED: Production Supervisor for medium sized Molding Plant. Experienced in all phases of production and personnel problems. Familiar with Thermosetting and Thermoplastic materials and willing to relocate in small town in Maryland. Write, giving qualifications and salary expected. Reply Box 3102, Modern Plastics.

MANUFACTURER'S REPRESENTATIVES: Well established manufacturers of Custom Injection Molded articles seeking top flight representation throughout the country. Straight commission in protected territories. Reply Box 3116, Modern Plastics.

LARGEST INJECTION MOLDER: in its field has opening in Eastern Branch Plant for a plastics engineer. Management functions include setting up a new department for mold maintenance and repair, establishment of a toolroom, liaison with custom tool makers, supervision of quality control department, and other related duties. Profit sharing arrangement. Send information. Reply Box 3123, Modern Plastics.

YOUNG PROGRESSIVE COMPANY: Located in Northern New Jersey has unusual opportunities for aggressive leaders. Salaries commensurate with abilities. Chief Engineer; experienced in estimating, designing and operating of injection molds, maintenance and repair of injection molding machines. Maintenance Tool Room Foreman; experienced in maintenance and repair of injection molds. If you qualify for one of these positions, send full details of education and experience to: Reply Box 3122, Modern Plastics.

MANUFACTURER'S SALES REPRESENTATIVE WANTED: Established, growing Midwest Company manufacturing, well-accepted, automatic, plastic injection molding machines, seeking active representatives in several choice areas in U. S. as well as Canada and Puerto Rico. Knowledge of injection molding desirable and association with plastic industry. Generous commission. Write fully giving territory covered, details of your organization, experience, lines presently carried, etc. Reply Box 3126, Modern Plastics.

Situations wanted

PLASTIC SALES REPRESENTATIVE: Desires to represent manufacturers of items suitable for the hand-bag; luggage and leather goods; belts — novelties; phonographs — carrying case fields in the United States and Canada. Sales experience includes: artificial leather; coated fabrics and papers; laminates, vinyls — pyroxylin materials, extrusions — injection molded handles. Age 29, college graduate; unmarried. Reply Box 3119, Modern Plastics.

POSITION WANTED: Plant Manager with 4 years of practical experience in all phases of extrusion work, desires job in the product development department or position in supervisory capacity. Familiar with profile die design and compounding. Reply 3104, Modern Plastics.

Miscellaneous

FOR SALE: Substantial interest in progressive molding company in Chicago area. Excellent opportunity for business requiring precision compression and transfer moldings. Reply Box 3124, Modern Plastics.

CUSTOM DESIGNER: New Type, High Production, Rotational Casting machine for vinyl plastisols. Low capital cost per production unit. Custom designed to meet your requirements. Sidney Levy, Plastics Consultant, 145 West Cuthbert Boulevard, Audubon 6, New Jersey.

PURCHASE: Styrene sheet extruding plant. Forward details of equipment and statement of fixed assets of major nature. Reply Box 3100, Modern Plastics.

DISTRIBUTOR:—In Canada interested in purchasing a vacuum forming plant either with or without an extruder in Montreal or Toronto. Cando Sales Limited, 871 Wilson Avenue, Downsview P.O. Toronto, Ontario.

Index of Advertisers

January 1958

Distribution of this issue: 32,800

MODERN PLASTICS

Published by Breskin Publications Inc., 575 Madison Ave., New York 22, N. Y.

"Is your secondary plasticizer going up the stack?"

Compare Chlorowax® 40 for low volatility

Outstandingly low volatility is one of the most important benefits Chlorowax 40 can bring to your vinyl compounds. Other secondary plasticizers may go "up the stack"—but this versatile chlorinated paraffin produces unsurpassed "permanence" in flexible vinyl plastic . . . gives consistently more uniform physical characteristics before and after aging.

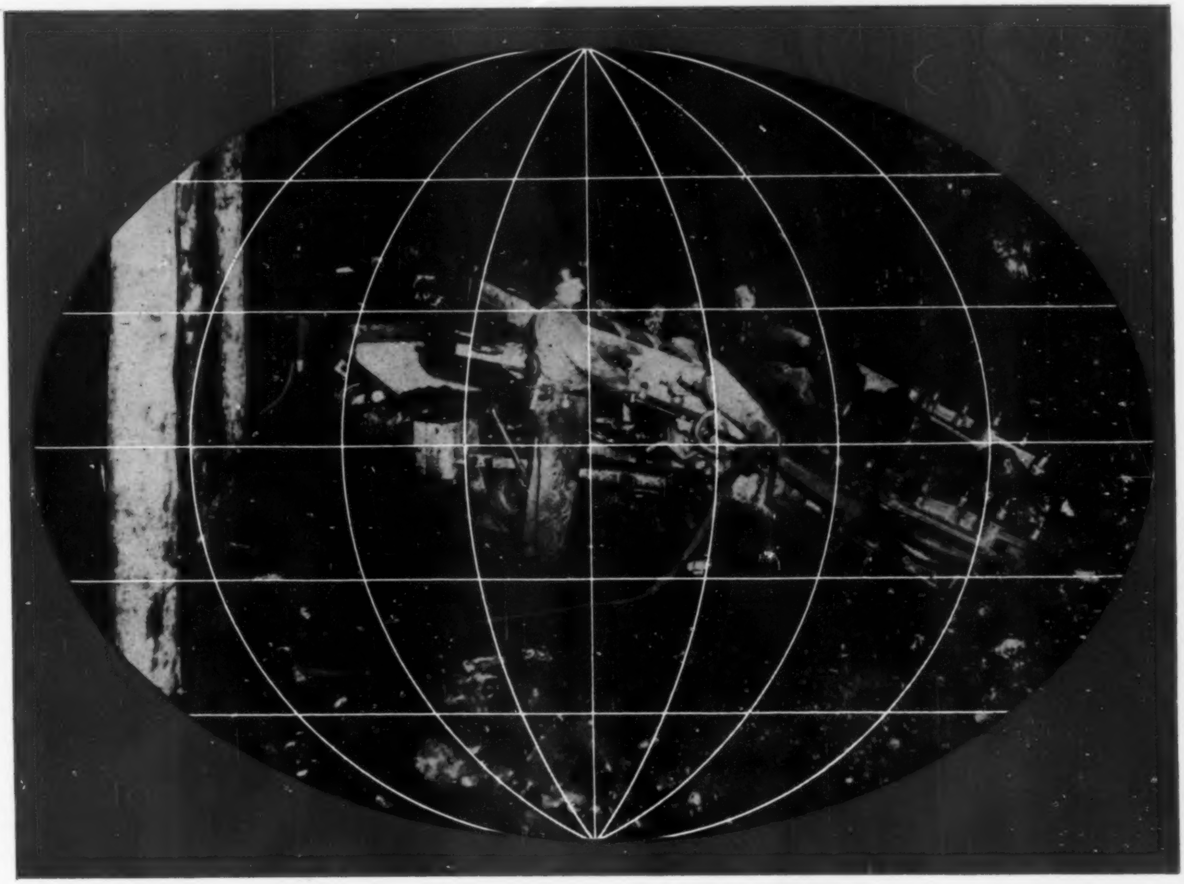
Compare the volatility of Chlorowax 40 with other materials used as secondary plasticizers.

Materials	Loss in Grams per Sq. Cm. per Hour at 212°F.
Chlorowax LV	.00004
Chlorowax 40	.00002
Chlorowax 50	.000015
DOP	.00002
Secondary #1	.00600
Secondary #2	.01200
Secondary #3	.000270
Secondary #4	.00300
Secondary #5	.01030

Other Chlorowax advantages are flame retardance, water repellence and chemical resistance. Use DIAMOND Chlorowax 40 as a secondary vinyl plasticizer to improve product characteristics, to help speed processing and reduce costs.

For information or technical co-operation, write DIAMOND ALKALI COMPANY, 300 Union Commerce Building, Cleveland 14, Ohio.

Diamond Chemicals



Best Place in the World to Start Making Quality Plasticizers

If your business is vinyls, you may have more interest than you realize in this coal mine. For the phthalate plasticizers you use aren't too many production steps removed from coal.

At Pittsburgh Coke & Chemical, we control every step of plasticizer production—from coal, through naphthalene and phthalic anhydride production to finished Pittsburgh PX Plasticizers. That's the best way we know to assure you of dependable, uniform quality and continuing, reliable supplies, regardless of marketing conditions.

But maybe we've overlooked the most important benefit our basic position offers you. And that's our view of the *future*—both *your* future and ours. Behind Pittsburgh's constantly growing investment in personnel and production facilities is a vigorous, long-range research program. Objective: To *continue* providing you with *better plasticizers at lower cost.*

Isn't this an important consideration to bear in mind as you plan *your* new and better plastic products of today . . . and *tomorrow?*

PITTSBURGH COKE & CHEMICAL CO.

WBW 6947

PITTSBURGH *Job-Rated* PLASTICIZERS

COAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

TAKE A GOOD LOOK AT THE HANDLES

. . . here's why they're molded from a G-E Phenolic "When you supply components to Black & Decker, you're on your mettle all the way," says S. H. Shaw, vice president of Shaw Insulator Co., Irvington, N. J. "When B&D gave us the job of molding the handles for their new Heavy-Duty Router, we knew that only the best would be good enough. They had to be light, strong and impervious to mars and scratches, even after long, hard use."

"Working closely with General Electric engineers, we perfected our molding technique, using *G-E 12920* to give us the required high finish and strength. This general-purpose compound cures fast for high production rates and has excellent flow properties. Another thing—we can use it for so many kinds of jobs that our inventory problems are simplified."

Many leading molders have found, like Mr. Shaw, that G-E phenolics are best for the high-specification jobs. But evaluate them for yourself—on molding characteristics and product performance. For information or technical assistance, write General Electric Company, Section MP 158, Chemical Materials Dept., Pittsfield, Mass.

Progress In Phenolics

GENERAL ELECTRIC